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Users are cautioned that Caltrans does not assume any liability or responsibility based on these electronic files or for any defective or incomplete copying, excerpting, scanning, faxing or downloading of the contract documents. As always, for the official paper versions of the bidders and non-bidder packages, write to the California Department of Transportation, Plans and Bid Documents, Room 0200, P.O. Box 942874, Sacramento, CA 94272-0001, telephone (916) 654-4490 or fax (916) 654-7028. Office hours are 7:30 a.m. to 4:15 p.m. When ordering bidder or non-bidder packages it is important that you include a telephone and fax number, P.O. Box and street address so that you can receive addenda.

Note: Addenda information is NOT included with the electronic documents available via electronic file transfer. Only bidder or non-bidder package holders listed with the Caltrans Plans and Bid Documents section as described above will receive addenda information.



**STATE OF CALIFORNIA**  
**DEPARTMENT OF TRANSPORTATION**

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**NOTICE TO CONTRACTORS**  
**AND**  
**SPECIAL PROVISIONS**  
**FOR CONSTRUCTION ON STATE HIGHWAY IN**  
**RIVERSIDE COUNTY AT VARIOUS LOCATIONS**

**DISTRICT 08, ROUTE 91**

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**For Use in Connection with Standard Specifications Dated JULY 1999, Standard Plans Dated JULY 1999, and Labor Surcharge and Equipment Rental Rates.**

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**CONTRACT NO. 08-449914**  
**08-Riv-91-11.9/18.4**

**Bids Open: September 14, 2000**  
**Dated: August 7, 2000**

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# IMPORTANT SPECIAL NOTICES

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- **SURETY 2000**

Caltrans is conducting a pilot program in cooperation with Surety 2000, to test electronic bond verification systems. The purpose of the pilot program is to test the use of Surety 2000 for verifying a bidder's bond electronically.

Surety 2000 is an Internet-based surety verification and security system, developed in conjunction with the surety industry. Surety agents may contact Surety 2000 at 1-800-660-3263.

Bidders are encouraged to participate in the pilot program. To participate, the bidder is asked to provide the "Authorization Code" provided by Surety 2000, on a separate sheet, together with the standard bidder's bond required by the specifications. The bidder's surety agent may obtain the "Authorization Code" from Surety 2000.

The Department will use the "Authorization Code" to access the Surety 2000 database, and independently verify the actual bidder's bond and document the functioning of the Surety 2000 system.

"Authorization Codes" will be used only to verify bidder's bonds, and only as part of the pilot program. The use of "Authorization Codes" will not be accepted in lieu of the bidder's bond or other bidder's security required in the specifications during the pilot study.

The function of the Surety 2000 system is to provide an easier way for Contractors to protect their bid security, and to discourage fraud. This system is available to all California admitted sureties and surety agents.

The results of the pilot study will be tabulated, and at some time in the future, the Department may consider accepting electronic bidder's bond verification in lieu of the bidder's bond specified.



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# STANDARD PLANS LIST

The Standard Plan sheets applicable to this contract include, but are not limited to those indicated below. The Revised Standard Plans (RSP) and New Standard Plans (NSP) which apply to this contract are included as individual sheets of the project plans.

A10A	Abbreviations
A10B	Symbols
T10	Traffic Control System for Lane Closure On Freeways and Expressways
T10A	Traffic Control System for Lane and Complete Closures On Freeways and Expressways
T14	Traffic Control System for Ramp Closure
RS1	Roadside Signs, Typical Installation Details No. 1
RS2	Roadside Signs - Wood Post, Typical Installation Details No. 2
ES-1A	Signal, Lighting and Electrical Systems - Symbols and Abbreviations
ES-1B	Signal, Lighting and Electrical Systems - Symbols and Abbreviations
ES-2A	Signal, Lighting and Electrical Systems - Service Equipment
ES-2F	Signal, Lighting and Electrical Systems - Service Equipment and Typical Wiring Diagram Type III-C Series
ES-3C	Signal, Lighting and Electrical Systems - Controller Cabinet Details
ES-5A	Signal, Lighting and Electrical Systems - Detectors
ES-5B	Signal, Lighting and Electrical Systems - Detectors
ES-5E	Signal, Lighting and Electrical Systems - Detectors
ES-8	Signal, Lighting and Electrical Systems - Pull Box Details
ES-11	Signal, Lighting and Electrical Systems - Foundation Installations
ES-13A	Signal, Lighting and Electrical Systems - Splicing Details
ES-16A	Closed Circuit Television Pole Details

State Project with DVBE Goals (06-14-00)

## DEPARTMENT OF TRANSPORTATION

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## NOTICE TO CONTRACTORS

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**CONTRACT NO. 08-449914**

**08-Riv-91-11.9/18.4**

Sealed proposals for the work shown on the plans entitled:

Contract No. 08-449914



**STATE OF CALIFORNIA; DEPARTMENT OF TRANSPORTATION; PROJECT PLANS FOR CONSTRUCTION  
ON STATE HIGHWAY IN RIVERSIDE COUNTY AT VARIOUS LOCATIONS**

will be received at the Department of Transportation, 3347 Michelson Drive, Suite 100, Irvine, CA 92612-1692, until 2 o'clock p.m. on September 14, 2000, at which time they will be publicly opened and read in Room C - 1116 at the same address.

Proposal forms for this work are included in a separate book entitled:

**STATE OF CALIFORNIA; DEPARTMENT OF TRANSPORTATION; PROPOSAL AND CONTRACT FOR  
CONSTRUCTION ON STATE HIGHWAY IN RIVERSIDE COUNTY AT VARIOUS LOCATIONS**

General work description: Install and connect CCTV, VDS and RMS to fiber optic system

This project has a goal of 3 percent disabled veteran business enterprise (DVBE) participation.

No prebid meeting is scheduled for this project.

Bids are required for the entire work described herein.

At the time this contract is awarded, the Contractor shall possess a Class A license, a Class C-7 or a Class C-10 license.

The Contractor must also be properly licensed at the time the bid is submitted, except that on a joint venture bid a joint venture license may be obtained by a combination of licenses after bid opening but before award in conformance with Business and Professions Code, Section 7029.1.

This contract is subject to state contract nondiscrimination and compliance requirements pursuant to Government Code, Section 12990.

Preference will be granted to bidders properly certified as a "Small Business" as determined by the Department of General Services, Office of Small Business Certification and Resources at the time of bid opening in conformance with the provisions in Section 2-1.05, "Small Business Preference," of the special provisions, and Section 1896 et seq, Title 2, California Code of Regulations. A form for requesting a "Small Business" preference is included with the bid documents. Applications for status as a "Small Business" must be submitted to the Department of General Services, Office of Small Business Certification and Resources, 1531 "I" Street, Second Floor, Sacramento, CA 95814, Telephone No. (916) 322-5060.

A reciprocal preference will be granted to "California company" bidders in conformance with Section 6107 of the Public Contract Code. (See Sections 2 and 3 of the special provisions.) A form for indicating whether bidders are or are not a "California company" is included in the bid documents and is to be filled in and signed by all bidders.

Project plans, special provisions, and proposal forms for bidding this project can only be obtained at the Department of Transportation, Plans and Bid Documents, Room 0200, MS #26, Transportation Building, 1120 N Street, Sacramento, California 95814, FAX No. (916) 654-7028, Telephone No. (916) 654-4490. Use FAX orders to expedite orders for project plans, special provisions and proposal forms. FAX orders must include credit card charge number, card expiration date and authorizing signature. Project plans, special provisions, and proposal forms may be seen at the above Department of Transportation office and at the offices of the District Directors of Transportation at Irvine, Oakland, and the district in which the work is situated. Standard Specifications and Standard Plans are available through the State of California, Department of Transportation, Publications Unit, 1900 Royal Oaks Drive, Sacramento, CA 95815, Telephone No. (916) 445-3520.

Cross sections for this project are not available.

The successful bidder shall furnish a payment bond and a performance bond.

Pursuant to Section 1773 of the Labor Code, the general prevailing wage rates in the county, or counties, in which the work is to be done have been determined by the Director of the California Department of Industrial Relations. These wages are set forth in the General Prevailing Wage Rates for this project, available at the Labor Compliance Office at the offices of the District Director of Transportation for the district in which the work is situated, and available from the California Department of Industrial Relations' Internet Web Site at: <http://www.dir.ca.gov>. Future effective general prevailing wage rates which have been predetermined and are on file with the Department of Industrial Relations are referenced but not printed in the general prevailing wage rates.

DEPARTMENT OF TRANSPORTATION

Deputy Director Transportation Engineering

Dated August 7, 2000

RS

**COPY OF ENGINEER'S ESTIMATE**  
**(NOT TO BE USED FOR BIDDING PURPOSES)**  
**08-449914**

Item	Item Code	Item	Unit of Measure	Estimated Quantity
1	120090	CONSTRUCTION AREA SIGNS	LS	LUMP SUM
2	120100	TRAFFIC CONTROL SYSTEM	LS	LUMP SUM
3	128650	PORTABLE CHANGEABLE MESSAGE SIGN	EA	2
4	860990	CLOSED CIRCUIT TELEVISION SYSTEM	LS	LUMP SUM
5	018713	VEHICLE DETECTION STATION (LOCATION 1)	LS	LUMP SUM
06	018714	VEHICLE DETECTION STATION (LOCATION 2)	LS	LUMP SUM
7	018715	VEHICLE DETECTION STATION (LOCATION 3)	LS	LUMP SUM
8	018716	VEHICLE DETECTION STATION (LOCATION 4)	LS	LUMP SUM
9	018717	MODIFY RAMP METERING SYSTEM (LOCATION 1)	LS	LUMP SUM
10	018718	MODIFY RAMP METERING SYSTEM (LOCATION 2)	LS	LUMP SUM
11	018719	MODIFY RAMP METERING SYSTEM (LOCATION 3)	LS	LUMP SUM
12	018720	MODIFY RAMP METERING SYSTEM (LOCATION 4)	LS	LUMP SUM
13	018721	MODIFY RAMP METERING SYSTEM (LOCATION 5)	LS	LUMP SUM
14	018722	MODIFY RAMP METERING SYSTEM (LOCATION 6)	LS	LUMP SUM
15	018723	TRAFFIC OPERATION SYSTEM CABINET ASSEMBLY	LS	LUMP SUM
16	018724	MODIFY COMMUNICATION HUB ASSEMBLY	LS	LUMP SUM
17	018725	MODIFY TRANSPORTATION MANAGEMENT CENTER	LS	LUMP SUM
18	869075	SYSTEM TESTING AND DOCUMENTATION	LS	LUMP SUM

**STATE OF CALIFORNIA**  
**DEPARTMENT OF TRANSPORTATION**

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**SPECIAL PROVISIONS**

**Annexed to Contract No. 08-449914**

**SECTION 1. SPECIFICATIONS AND PLANS**

The work embraced herein shall conform to the provisions in the Standard Specifications dated July 1999, and the Standard Plans dated July 1999, of the Department of Transportation insofar as the same may apply, and these special provisions.

Amendments to the Standard Specifications set forth in these special provisions shall be considered as part of the Standard Specifications for the purposes set forth in Section 5-1.04, "Coordination and Interpretation of Plans, Standard Specifications and Special Provisions," of the Standard Specifications. Whenever either the term "Standard Specifications are amended" or the term "Standard Specifications are amended" is used in the special provisions, the indented text or table following the term shall be considered an amendment to the Standard Specifications. In case of conflict between such amendments and the Standard Specifications, the amendments shall take precedence over and be used in lieu of the conflicting portions.

In case of conflict between the Standard Specifications and these special provisions, the special provisions shall take precedence over and shall be used in lieu of the conflicting portions.

**SECTION 2. PROPOSAL REQUIREMENTS AND CONDITIONS**

**2-1.01 GENERAL**

The bidder's attention is directed to the provisions in Section 2, "Proposal Requirements and Conditions," of the Standard Specifications and these special provisions for the requirements and conditions which the bidder must observe in the preparation of the proposal form and the submission of the bid.

In addition to the subcontractors required to be listed in conformance with Section 2-1.054, "Required Listing of Proposed Subcontractors," of the Standard Specifications, each proposal shall have listed therein the name and address of each DVBE subcontractor to be used for credit in meeting the goal, and to whom the bidder proposes to directly subcontract portions of the work. The list of subcontractors shall also set forth the portion of work that will be performed by each subcontractor listed. A sheet for listing the subcontractors is included in the Proposal.

The Bidder's Bond form mentioned in the last paragraph in Section 2-1.07, "Proposal Guaranty," of the Standard Specifications will be found following the signature page of the Proposal.

In conformance with Public Contract Code Section 7106, a Noncollusion Affidavit is included in the Proposal. Signing the Proposal shall also constitute signature of the Noncollusion Affidavit.

Submit request for substitution of an "or equal" item, and the data substantiating the request to the Department of Transportation, District 8 Construction, MS 1104, 464 West 4th Street, 6th Floor, San Bernardino, Ca 92401-1400, so that the request is received by the Department by close of business on the fourth day, not including Saturdays, Sundays and legal holidays, following bid opening.

**2-1.02 DISABLED VETERAN BUSINESS ENTERPRISE (DVBE)**

Section 10115 of the Public Contract Code requires the Department to implement provisions to establish a goal for Disabled Veterans Business Enterprise (DVBE) in contracts.

It is the policy of the Department that Disabled Veteran Business Enterprise (DVBE) shall have the maximum opportunity to participate in the performance of contracts financed solely with state funds. The Contractor shall ensure that DVBEs have the maximum opportunity to participate in the performance of this contract and shall take all necessary and reasonable steps for this assurance. The Contractor shall not discriminate on the basis of race, color, national origin, or sex in the award and performance of subcontracts. Failure to carry out the requirements of this paragraph shall constitute a breach of contract and may result in termination of this contract or other remedy the Department may deem appropriate.

Bidder's attention is directed to the following:

- A. "Disabled Veteran Business Enterprise" (DVBE) means a business concern certified as a DVBE by the Office of Small Business Certification and Resources, Department of General Services.
- B. A DVBE may participate as a prime contractor, subcontractor, joint venture partner with a prime or subcontractor, or vendor of material or supplies.
- C. Credit for DVBE prime contractors will be 100 percent.
- D. A DVBE joint venture partner must be responsible for specific contract items of work, or portions thereof. Responsibility means actually performing, managing and supervising the work with its own forces. The DVBE joint venture partner must share in the ownership, control, management responsibilities, risks and profits of the joint venture. The DVBE joint venturer must submit the joint venture agreement with the Caltrans Bidder DVBE Information form required in Section 2-1.04, "Submission of DVBE Information," elsewhere in these special provisions.
- E. A DVBE must perform a commercially useful function, i.e., must be responsible for the execution of a distinct element of the work and must carry out its responsibility by actually performing, managing and supervising the work.
- F. Credit for DVBE vendors of materials or supplies is limited to 60 percent of the amount to be paid to the vendor for the material unless the vendor manufactures or substantially alters the goods.
- G. Credit for trucking by DVBEs will be as follows:
  - 1. One hundred percent of the amount to be paid when a DVBE trucker will perform the trucking with his/her own trucks, tractors and employees.
  - 2. Twenty percent of the amount to be paid to DVBE trucking brokers who do not have a "certified roster."
  - 3. One hundred percent of the amount to be paid to DVBE trucking brokers who have signed agreements that all trucking will be performed by DVBE truckers if credit is toward the DVBE goal, a "certified roster" showing that all trucks are owned by DVBEs, and a signed statement on the "certified roster" that indicates that 100 percent of revenue paid by the broker will be paid to the DVBEs listed on the "certified roster."
  - 4. Twenty percent of the amount to be paid to trucking brokers who are not a DVBE but who have signed agreements with DVBE truckers assuring that at least 20 percent of the trucking will be performed by DVBE truckers if credit is toward the DVBE goal, a "certified roster" showing that at least 20 percent of the number of trucks are owned by DVBE truckers, and a signed statement on the "certified roster" that indicates that at least 20 percent of the revenue paid by the broker will be paid to the DVBEs listed on the "certified roster."

The "certified roster" referred to herein shall conform to the requirements in Section 2-1.04, "Submission Of DVBE Information," elsewhere in these special provisions.

- H. DVBEs and DVBE joint venture partners must be certified DVBEs as determined by the Department of General Services, Office of Small Business Certification and Resources, 1531 "I" Street, Second Floor, Sacramento, CA 95814, on the date bids for the project are opened before credit may be allowed toward the DVBE goal. It is the Contractor's responsibility to verify that DVBEs are certified.
- I. Noncompliance by the Contractor with these requirements constitutes a breach of this contract and may result in termination of the contract or other appropriate remedy for a breach of this contract.

### **2-1.03 DVBE GOAL FOR THIS PROJECT**

The Department has established the following goal for Disabled Veteran Business Enterprise (DVBE) participation for this project:

Disabled Veteran Business Enterprise (DVBE): 3 percent.

It is the bidder's responsibility to make a sufficient portion of the work available to subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DVBE subcontractors and suppliers, so as to assure meeting the goal for DVBE participation.

The Office of Small Business Certification and Resources, Department of General Services, may be contacted at (916) 322-5060 or visit their internet web site at <http://www.osmb.dgs.ca.gov/> for program information and certification status. The Department's Business Enterprise Program may also be contacted at (916) 227-9599 or the internet web site at <http://www.dot.ca.gov/hq/bep/>.

### **2-1.04 SUBMISSION OF DVBE INFORMATION**

The required DVBE information shall be submitted on the "CALTRANS BIDDER - DVBE INFORMATION" form included in the Proposal. If this information is not submitted with the bid, the DVBE information forms shall be removed from the documents prior to submitting the bid.

It is the bidder's responsibility to make enough work available to DVBEs and to select those portions of the work or material needs consistent with the available DVBEs to meet the goal for DVBE participation or to provide information to establish that, prior to bidding, the bidder made adequate good faith efforts to do so.

If the DVBE information is not submitted with the bid, the apparent successful bidder (low bidder), the second low bidder and the third low bidder shall submit the DVBE information to the Department of Transportation, 1120 N Street, Room 0200, MS #26, Sacramento, California 95814 so the information is received by the Department no later than 4:00 p.m. on the fourth day, not including Saturdays, Sundays and legal holidays, following bid opening. DVBE information sent by U.S. Postal Service certified mail with return receipt and certificate of mailing and mailed on or before the third day, not including Saturdays, Sundays and legal holidays, following bid opening will be accepted even if it is received after the fourth day following bid opening. Failure to submit the required DVBE information by the time specified will be grounds for finding the bid or proposal nonresponsive. Other bidders need not submit DVBE information unless requested to do so by the Department.

The bidder's DVBE information shall establish that good faith efforts to meet the DVBE goal have been made. To establish good faith efforts, the bidder shall demonstrate that the goal will be met or that, prior to bidding, adequate good faith efforts to meet the goal were made.

Bidders are cautioned that even though their submittal indicates they will meet the stated DVBE goal, their submittal should also include their adequate good faith efforts information along with their DVBE goal information to protect their eligibility for award of the contract in the event the Department, in its review, finds that the goal has not been met.

The bidder's DVBE information shall include the names of DVBE firms that will participate, with a complete description of work or supplies to be provided by each, the dollar value of each DVBE transaction, and a written confirmation from the DVBE that it is participating in the contract. A copy of the DVBE's quote will serve as written confirmation that the DVBE is participating in the contract. When 100 percent of a contract item of work is not to be performed or furnished by a DVBE, a description of the exact portion of that work to be performed or furnished by that DVBE shall be included in the DVBE information, including the planned location of that work. The work that a DVBE prime contractor has committed to performing with its own forces as well as the work that it has committed to be performed by DVBE subcontractors, suppliers and trucking companies will count toward the goal.

If credit for trucking by a DVBE trucking broker is shown on the bidder's information as 100 percent of the revenue to be paid by the broker is to be paid to DVBE truckers, a "certified roster" of the broker's trucks to be used must be included. The "certified roster" must indicate that all the trucks are owned by certified DVBEs and must show the DVBE truck numbers, owner's name, Public Utilities Commission Cal-T numbers, and the DVBE certification numbers. The roster must indicate that all revenue paid by the broker will be paid to DVBEs listed on the "certified roster".

If credit for trucking by a trucking broker who is not a DVBE is shown in the bidder's information, a "certified roster" of the broker's trucks to be used must be included. The "certified roster" must indicate that at least 20 percent of the broker's trucks are owned by certified DVBEs and must show the DVBE truck numbers, owner's name, Public Utilities Commission Cal-T numbers, and the DVBE certification number. The roster must indicate that at least 20 percent of the revenue paid by the broker will be paid to DVBEs listed on the "certified roster".

A bidder shall be deemed to have made good faith efforts upon submittal, within time limits specified by the Department, of documentary evidence that all of the following actions were taken:

- A. Contact was made with the Office of Small Business Certification and Resources (OSBCR), Department of General Services or their web site at <http://www.osmb.dgs.ca.gov/> to identify Disabled Veteran Business Enterprises.
- B. Advertising was published in trade media and media focusing on Disabled Veteran Business Enterprises, unless time limits imposed by the Department do not permit that advertising.
- C. Invitations to bid were submitted to potential Disabled Veteran Business Enterprise contractors.
- D. Available Disabled Veteran Business Enterprises were considered.

## **2-1.05 SMALL BUSINESS PREFERENCE**

Attention is directed to "Award and Execution of Contract" of these special provisions.

Attention is also directed to the Small Business Procurement and Contract Act, Government Code Section 14835, et seq and Title 2, California Code of Regulations, Section 1896, et seq.

Bidders who wish to be classified as a Small Business under the provisions of those laws and regulations, shall be certified as Small Business by the Department of General Services, Office of Small Business Certification and Resources, 1531 "I" Street, Second Floor, Sacramento, CA 95814.

To request Small Business Preference, bidders shall fill out and sign the Request for Small Business Preference form in the Proposal and shall attach a copy of their Office of Small Business Certification and Resources (OSBCR) small business certification letter to the form. The bidder's signature on the Request for Small Business Preference certifies, under penalty of perjury, that the bidder is certified as Small Business at the time of bid opening and further certifies, under penalty of perjury, that under the following conditions, at least 50 percent of the subcontractors to be utilized on the project are either

certified Small Business or have applied for Small Business certification by bid opening date and are subsequently granted Small Business certification.

The conditions requiring the aforementioned 50 percent level of subcontracting by Small Business subcontractors apply if:

- A. The lowest responsible bid for the project exceeds \$100,000; and
- B. The project work to be performed requires a Class A or a Class B contractor's license; and
- C. Two or more subcontractors will be used.

If the above conditions apply and Small Business Preference is granted in the award of the contract, the 50 percent Small Business subcontractor utilization level shall be maintained throughout the life of the contract.

## **2-1.06 CALIFORNIA COMPANY PREFERENCE**

Attention is directed to "Award and Execution of Contract" of these special provisions.

In conformance with the requirements of Section 6107 of the Public Contract Code, a "California company" will be granted a reciprocal preference for bid comparison purposes as against a nonresident contractor from any state that gives or requires a preference to be given contractors from that state on its public entity construction contracts.

A "California company" means a sole proprietorship, partnership, joint venture, corporation, or other business entity that was a licensed California contractor on the date when bids for the public contract were opened and meets one of the following:

- A. Has its principal place of business in California.
- B. Has its principal place of business in a state in which there is no local contractor preference on construction contracts.
- C. Has its principal place of business in a state in which there is a local contractor construction preference and the contractor has paid not less than \$5000 in sales or use taxes to California for construction related activity for each of the five years immediately preceding the submission of the bid.

To carry out the "California company" reciprocal preference requirements of Section 6107 of the Public Contract Code, all bidders shall fill out and sign the California Company Preference form in the Proposal. The bidder's signature on the California Company Preference form certifies, under penalty of perjury, that the bidder is or is not a "California company" and if not, the amount of the preference applied by the state of the nonresident Contractor.

A nonresident Contractor shall disclose any and all bid preferences provided to the nonresident Contractor by the state or country in which the nonresident Contractor has its principal place of business.

Proposals without the California Company Preference form filled out and signed may be rejected.

## **SECTION 3. AWARD AND EXECUTION OF CONTRACT**

The bidder's attention is directed to the provisions in Section 3, "Award and Execution of Contract," of the Standard Specifications and these special provisions for the requirements and conditions concerning award and execution of contract.

The award of the contract, if it be awarded, will be to the lowest responsible bidder whose proposal complies with all the requirements prescribed and who has met the goal for DVBE participation or has demonstrated, to the satisfaction of the Department, adequate good faith efforts to do so. Meeting the goal for DVBE participation or demonstrating, to the satisfaction of the Department, adequate good faith efforts to do so is a condition for being eligible for award of contract.

A "Payee Data Record" form will be included in the contract documents to be executed by the successful bidder. The purpose of the form is to facilitate the collection of taxpayer identification data. The form shall be completed and returned to the Department by the successful bidder with the executed contract and contract bonds. For the purposes of the form, payee shall be deemed to mean the successful bidder. The form is not to be completed for subcontractors or suppliers. Failure to complete and return the "Payee Data Record" form to the Department as provided herein will result in the retention of 20 percent of payments due the contractor and penalties of up to \$20,000. This retention of payments for failure to complete the "Payee Data Record" form is in addition to any other retention of payments due the Contractor.

Attention is also directed to "Small Business Preference" of these special provisions. Any bidder who is certified as a Small Business by the Department of General Services, Office of Small Business Certification and Resources will be allowed a preference in the award of this contract, if it be awarded, under the following conditions:

- A. The apparent low bidder is not certified as a Small Business, or has not filled out and signed the Request for Small Business Preference included with the bid documents and attached a copy of their Office of Small Business Certification and Resources (OSBCR) small business certification letter to the form; and

- B. The bidder filled out and signed the Request for Small Business Preference form included with the bid documents and attached a copy of their Office of Small Business Certification and Resources (OSBCR) small business certification letter to the form.

The small business preference will be a reduction in the bid submitted by the small business contractor, for bid comparison purposes, by an amount equal to 5 percent of the amount bid by the apparent low bidder, the amount not to exceed \$50,000. If this reduction results in the small business contractor becoming the low bidder, then the contract will be awarded to the small business contractor on the basis of the actual bid of the small business contractor notwithstanding the reduced bid price used for bid comparison purposes.

Attention is also directed to "California Company Preference" of these special provisions.

The amount of the California company reciprocal preference shall be equal to the amount of the preference applied by the state of the nonresident contractor with the lowest responsive bid, except where the "California company" is eligible for a California Small Business Preference, in which case the preference applied shall be the greater of the two, but not both.

If the bidder submitting the lowest responsive bid is not a "California company" and with the benefit of the reciprocal preference, a "California company's" responsive bid is equal to or less than the original lowest responsive bid, the "California company" will be awarded the contract at its submitted bid price except as provided below.

Small business bidders shall have precedence over nonsmall business bidders in that the application of the "California company" preference for which nonsmall business bidders may be eligible shall not result in the denial of the award to a small business bidder.

#### **SECTION 4. BEGINNING OF WORK, TIME OF COMPLETION AND LIQUIDATED DAMAGES**

Attention is directed to the provisions in Section 8-1.03, "Beginning of Work," in Section 8-1.06, "Time of Completion," and in Section 8-1.07, "Liquidated Damages," of the Standard Specifications and these special provisions.

The Contractor shall furnish the Engineer with a statement from the vendor that the order for the electrical materials required for this contract has been received and accepted by the vendor; and the statement shall be furnished within 15 calendar days after the contract has been approved by the Attorney General, or the attorney appointed and authorized to represent the Department of Transportation. The statement shall give the date that the electrical materials will be shipped. If the Contractor has the necessary materials on hand, the Contractor will not be required to furnish the vendor's statement.

The Contractor shall begin work within 90 calendar days after the contract has been approved by the Attorney General or the attorney appointed and authorized to represent the Department of Transportation.

The work shall be diligently prosecuted to completion before the expiration of **100 WORKING DAYS** beginning on the date that work begins, or beginning on the ninetieth calendar day after approval of the contract, whichever occurs first.

The Contractor shall pay to the State of California the sum of \$300 per day, for each and every calendar day's delay in finishing the work in excess of the number of working days prescribed above.

The 72 hours advance notice before beginning work specified in Section 8-1.03, "Beginning of Work," of the Standard Specifications is changed to 5 days advance notice for this project.

#### **SECTION 5. GENERAL**

##### **SECTION 5-1. MISCELLANEOUS**

###### **5-1.01 PLANS AND WORKING DRAWINGS**

When the specifications require working drawings to be submitted to the Division of Structure Design, the drawings shall be submitted to: Division of Structure Design, Documents Unit, Mail Station 9, 1801 30th Street, Sacramento, CA 95816, Telephone 916 227-8252.

###### **5-1.015 LABORATORY**

When a reference is made in the specifications to the "Laboratory," the reference shall mean the Division of Materials Engineering and Testing Services and the Division of Structural Foundations of the Department of Transportation, or established laboratories of the various Districts of the Department, or other laboratories authorized by the Department to test materials and work involved in the contract. When a reference is made in the specifications to the "Transportation Laboratory," the reference shall mean the Division of Materials Engineering and Testing Services and the Division of Structural Foundations, located at 5900 Folsom Boulevard, Sacramento, CA 95819, Telephone (916) 227-7000.



### **5-1.02 LABOR NONDISCRIMINATION**

Attention is directed to the following Notice that is required by Chapter 5 of Division 4 of Title 2, California Code of Regulations.

#### **NOTICE OF REQUIREMENT FOR NONDISCRIMINATION PROGRAM (GOV. CODE, SECTION 12990)**

Your attention is called to the "Nondiscrimination Clause", set forth in Section 7-1.01A(4), "Labor Nondiscrimination," of the Standard Specifications, which is applicable to all nonexempt State contracts and subcontracts, and to the "Standard California Nondiscrimination Construction Contract Specifications" set forth therein. The specifications are applicable to all nonexempt State construction contracts and subcontracts of \$5000 or more.

### **5-1.03 INTEREST ON PAYMENTS**

Interest shall be payable on progress payments, payments after acceptance, final payments, extra work payments, and claim payments as follows:

- A. Unpaid progress payments, payment after acceptance, and final payments shall begin to accrue interest 30 days after the Engineer prepares the payment estimate.
- B. Unpaid extra work bills shall begin to accrue interest 30 days after preparation of the first pay estimate following receipt of a properly submitted and undisputed extra work bill. To be properly submitted, the bill must be submitted within 7 days of the performance of the extra work and in conformance with the provisions in Section 9-1.03C, "Records," and Section 9-1.06, "Partial Payments," of the Standard Specifications. An undisputed extra work bill not submitted within 7 days of performance of the extra work will begin to accrue interest 30 days after the preparation of the second pay estimate following submittal of the bill.
- C. The rate of interest payable for unpaid progress payments, payments after acceptance, final payments, and extra work payments shall be 10 percent per annum.
- D. The rate of interest payable on a claim, protest or dispute ultimately allowed under this contract shall be 6 percent per annum. Interest shall begin to accrue 61 days after the Contractor submits to the Engineer information in sufficient detail to enable the Engineer to ascertain the basis and amount of said claim, protest or dispute.

The rate of interest payable on any award in arbitration shall be 6 percent per annum if allowed under the provisions of Civil Code Section 3289.

### **5-1.04 PUBLIC SAFETY**

The Contractor shall provide for the safety of traffic and the public in conformance with the provisions in Section 7-1.09, "Public Safety," of the Standard Specifications and these special provisions.

The Contractor shall install temporary railing (Type K) between a lane open to public traffic and an excavation, obstacle or storage area when the following conditions exist:

- A. Excavations.—The near edge of the excavation is 3.6 m or less from the edge of the lane, except:
  - 1. Excavations covered with sheet steel or concrete covers of adequate thickness to prevent accidental entry by traffic or the public.
  - 2. Excavations less than 0.3-m deep.
  - 3. Trenches less than 0.3-m wide for irrigation pipe or electrical conduit, or excavations less than 0.3-m in diameter.
  - 4. Excavations parallel to the lane for the purpose of pavement widening or reconstruction.
  - 5. Excavations in side slopes, where the slope is steeper than 1:4 (vertical:horizontal).
  - 6. Excavations protected by existing barrier or railing.
- B. Temporarily Unprotected Permanent Obstacles.—The work includes the installation of a fixed obstacle together with a protective system, such as a sign structure together with protective railing, and the Contractor elects to install the obstacle prior to installing the protective system; or the Contractor, for the Contractor's convenience and with permission of the Engineer, removes a portion of an existing protective railing at an obstacle and does not replace such railing complete in place during the same day.
- C. Storage Areas.—Material or equipment is stored within 3.6 m of the lane and the storage is not otherwise prohibited by the provisions of the Standard Specifications and these special provisions.

The approach end of temporary railing (Type K), installed in conformance with the provisions in this section "Public Safety" and in Section 7-1.09, "Public Safety," of the Standard Specifications, shall be offset a minimum of 4.6 m from the edge of the traffic lane open to public traffic. The temporary railing shall be installed on a skew toward the edge of the traffic lane of not more than 0.3-m transversely to 3 m longitudinally with respect to the edge of the traffic lane. If the 4.6-m minimum offset cannot be achieved, the temporary railing shall be installed on the 10 to 1 skew to obtain the maximum available offset between the approach end of the railing and the edge of the traffic lane, and an array of temporary crash cushion modules shall be installed at the approach end of the temporary railing.

Temporary railing (Type K) shall conform to the provisions in Section 12-3.08, "Temporary Railing (Type K)," of the Standard Specifications. Temporary railing (Type K), conforming to the details shown on 1999 Standard Plan T3, may be used. Temporary railing (Type K) fabricated prior to January 1, 1993, and conforming to 1988 Standard Plan B11-30 may be used, provided the fabrication date is printed on the required Certificate of Compliance.

Temporary crash cushion modules shall conform to the provisions in "Temporary Crash Cushion Module" of these special provisions.

Except for installing, maintaining and removing traffic control devices, whenever work is performed or equipment is operated in the following work areas, the Contractor shall close the adjacent traffic lane unless otherwise provided in the Standard Specifications and these special provisions:

Approach Speed of Public Traffic (Posted Limit) (Kilometers Per Hour)	Work Areas
Over 72 (45 Miles Per Hour)	Within 1.8 m of a traffic lane but not on a traffic lane
56 to 72 (35 to 45 Miles Per Hour)	Within 0.9-m of a traffic lane but not on a traffic lane

The lane closure provisions of this section shall not apply if the work area is protected by permanent or temporary railing or barrier.

When traffic cones or delineators are used to delineate a temporary edge of a traffic lane, the line of cones or delineators shall be considered to be the edge of the traffic lane, however, the Contractor shall not reduce the width of an existing lane to less than 3 m without written approval from the Engineer.

When work is not in progress on a trench or other excavation that required closure of an adjacent lane, the traffic cones or portable delineators used for the lane closure shall be placed off of and adjacent to the edge of the traveled way. The spacing of the cones or delineators shall be not more than the spacing used for the lane closure.

Suspended loads or equipment shall not be moved nor positioned over public traffic or pedestrians.

Full compensation for conforming to the provisions in this section "Public Safety," including furnishing and installing temporary railing (Type K) and temporary crash cushion modules, shall be considered as included in the contract prices paid for the various items of work involved and no additional compensation will be allowed therefor.

#### **5-1.05 SURFACE MINING AND RECLAMATION ACT**

Attention is directed to the Surface Mining and Reclamation Act of 1975, commencing in Public Resources Code, Mining and Geology, Section 2710, which establishes regulations pertinent to surface mining operations.

Material from mining operations furnished for this project shall only come from permitted sites in compliance with the Surface Mining and Reclamation Act of 1975.

The requirements of this section shall apply to materials furnished for the project, except for acquisition of materials in conformance with the provisions in Section 4-1.05, "Use of Materials Found on the Work," of the Standard Specifications.

#### **5-1.06 REMOVAL OF ASBESTOS AND HAZARDOUS SUBSTANCES**

When the presence of asbestos or hazardous substances are not shown on the plans or indicated in the specifications and the Contractor encounters materials which the Contractor reasonably believes to be asbestos or a hazardous substance as defined in Section 25914.1 of the Health and Safety Code, and the asbestos or hazardous substance has not been rendered harmless, the Contractor may continue work in unaffected areas reasonably believed to be safe. The Contractor shall immediately cease work in the affected area and report the condition to the Engineer in writing.

In conformance with Section 25914.1 of the Health and Safety Code, removal of asbestos or hazardous substances including exploratory work to identify and determine the extent of the asbestos or hazardous substance will be performed by separate contract.

If delay of work in the area delays the current controlling operation, the delay will be considered a right of way delay and the Contractor will be compensated for the delay in conformance with the provisions in Section 8-1.09, "Right of Way Delays," of the Standard Specifications.

### **5-1.07 YEAR 2000 COMPLIANCE**

This contract is subject to Year 2000 Compliance for automated devices in the State of California.

Year 2000 compliance for automated devices in the State of California is achieved when embedded functions have or create no logical or mathematical inconsistencies when dealing with dates prior to and beyond 1999. The year 2000 is recognized and processed as a leap year. The product shall operate accurately in the manner in which the product was intended for date operation without requiring manual intervention.

The Contractor shall provide the Engineer a Certificate of Compliance from the manufacturer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for all automated devices furnished for the project.

### **5-1.08 SUBCONTRACTOR AND DVBE RECORDS**

The Contractor shall maintain records of all subcontracts entered into with certified DVBE subcontractors and records of materials purchased from certified DVBE suppliers. The records shall show the name and business address of each DVBE subcontractor or vendor and the total dollar amount actually paid each DVBE subcontractor or vendor.

Upon completion of the contract, a summary of these records shall be prepared on Form CEM-2402 (S) and certified correct by the Contractor or the Contractor's authorized representative, and shall be furnished to the Engineer.

### **5-1.086 PERFORMANCE OF DVBE SUBCONTRACTORS AND SUPPLIERS**

The DVBEs listed by the Contractor in response to the provisions in Section 2-1.04, "Submission of DVBE Information," and Section 3, "Award and Execution of Contract," of these special provisions, which are determined by the Department to be certified DVBEs, shall perform the work and supply the materials for which they are listed, unless the Contractor has received prior written authorization to perform the work with other forces or to obtain the materials from other sources.

Authorization to utilize other forces or sources of materials may be requested for the following reasons:

- A. The listed DVBE, after having had a reasonable opportunity to do so, fails or refuses to execute a written contract, when the written contract, based upon the general terms, conditions, plans and specifications for the project, or on the terms of the subcontractor's or supplier's written bid, is presented by the Contractor.
- B. The listed DVBE becomes bankrupt or insolvent.
- C. The listed DVBE fails or refuses to perform the subcontract or furnish the listed materials.
- D. The Contractor stipulated that a bond was a condition of executing a subcontract and the listed DVBE subcontractor fails or refuses to meet the bond requirements of the Contractor.
- E. The work performed by the listed subcontractor is substantially unsatisfactory and is not in substantial conformance with the plans and specifications or the subcontractor is substantially delaying or disrupting the progress of the work.
- F. The listed DVBE subcontractor is not licensed pursuant to the Contractor's License Law.
- G. It would be in the best interest of the State.

The Contractor shall not be entitled to payment for the work or material unless it is performed or supplied by the listed DVBE or by other forces (including those of the Contractor) pursuant to prior written authorization of the Engineer.

### **5-1.09 SUBCONTRACTING**

Attention is directed to the provisions in Section 8-1.01, "Subcontracting," of the Standard Specifications, Section 2, "Proposal Requirements and Conditions," Section 2-1.04, "Submission of DVBE Information," and Section 3, "Award and Execution of Contract," of these special provisions and these special provisions.

Pursuant to the provisions in Section 1777.1 of the Labor Code, the Labor Commissioner publishes and distributes a list of contractors ineligible to perform work as a subcontractor on a public works project. This list of debarred contractors is available from the Department of Industrial Relations web site at:

<http://www.dir.ca.gov/DLSE/Debar.html>.

The first sentence in the third paragraph of Section 8-1.01, "Subcontracting," of the Standard Specifications shall not apply.

The Contractor shall perform with the Contractor's own organization contract work amounting to not less than 30 percent of the original total contract price, except that any designated "Specialty Items" may be performed by subcontract and the amount of "Specialty Items" so performed may be deducted from the original total contract price before computing the amount of work required to be performed by the Contractor with the Contractor's own organization.

The DVBE information furnished under Section 3-1.01A, "DVBE Information," of these special provisions is in addition to the subcontractor information required to be furnished in Section 8-1.01, "Subcontracting," and Section 2-1.054, "Required Listing of Proposed Subcontractors," of the Standard Specifications.

Section 10115 of the Public Contract Code requires the Department to implement provisions to establish a goal for Disabled Veteran Business Enterprise (DVBE) participation in highway contracts that are State funded. As a part of this requirement:

- A. No substitution of a DVBE subcontractor shall be made at any time without the written consent of the Department, and
- B. If a DVBE subcontractor is unable to perform successfully and is to be replaced, the Contractor shall make good faith efforts to replace the original DVBE subcontractor with another DVBE subcontractor.

The provisions in Section 2-1.02, "Disabled Veteran Business Enterprise (DVBE)," of these special provisions that DVBEs shall be certified on the date bids are opened does not apply to DVBE substitutions after award of the contract.

#### **5-1.10 PROMPT PROGRESS PAYMENT TO SUBCONTRACTORS**

Attention is directed to the provisions in Sections 10262 and 10262.5 of the Public Contract Code and Section 7108.5 of the Business and Professions Code concerning prompt payment to subcontractors.

#### **5-1.11 AREAS FOR CONTRACTOR'S USE**

Attention is directed to the provisions in Section 7-1.19, "Rights in Land and Improvements," of the Standard Specifications and these special provisions.

The highway right of way shall be used only for purposes that are necessary to perform the required work. The Contractor shall not occupy the right of way, or allow others to occupy the right of way, for purposes which are not necessary to perform the required work.

Residence trailers will not be allowed within the highway right of way, except that one trailer will be allowed for yard security purposes.

The Contractor shall remove equipment, materials, and rubbish from the work areas and other State-owned property which the Contractor occupies. The Contractor shall leave the areas in a presentable condition in conformance with the provisions in Section 4-1.02, "Final Cleaning Up," of the Standard Specifications.

The Contractor shall secure, at the Contractor's own expense, areas required for plant sites, storage of equipment or materials or for other purposes, if sufficient area is not available to the Contractor within the contract limits, or at the sites designated on the plans outside the contract limits.

#### **5-1.12 PAYMENTS**

Attention is directed to Sections 9-1.06, "Partial Payments," and 9-1.07, "Payment After Acceptance," of the Standard Specifications and these special provisions.

In determining the partial payments to be made to the Contractor, only the following listed materials will be considered for inclusion in the payment as materials furnished but not incorporated in the work:

- A. Closed Circuit Television (CCTV) Camera Assembly
- B. Fiber Optic Cables
- C. Fiber Optic Conduit
- D. Innerducts

#### **5-1.13 SOUND CONTROL REQUIREMENTS**

Sound control shall conform to the provisions in Section 7-1.01I, "Sound Control Requirements," of the Standard Specifications and these special provisions.

The noise level from the Contractor's operations, between the hours of 9:00 p.m. and 6:00 a.m., shall not exceed 86 dbA at a distance of 15 m. This requirement shall not relieve the Contractor from responsibility for complying with local ordinances regulating noise level.

The noise level requirement shall apply to the equipment on the job or related to the job, including but not limited to trucks, transit mixers or transient equipment that may or may not be owned by the Contractor. The use of loud sound signals shall be avoided in favor of light warnings except those required by safety laws for the protection of personnel.

Full compensation for conforming to the requirements of this section shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefor.

**SECTION 6. (BLANK)**

**SECTION 7. (BLANK)**

**SECTION 8. MATERIALS**

**SECTION 8-1. MISCELLANEOUS**

**8-1.01 SUBSTITUTION OF NON-METRIC MATERIALS AND PRODUCTS**

Only materials and products conforming to the requirements of the specifications shall be incorporated in the work. When metric materials and products are not available, and when approved by the Engineer, and at no cost to the State, materials and products in the inch-pound (Imperial) system which are of equal quality and of the required properties and characteristics for the purpose intended, may be substituted for the equivalent metric materials and products, subject to the following provisions:

- A. Materials and products shown on the plans or in the special provisions as being equivalent may be substituted for the metric materials and products specified or detailed on the plans.
- B. Before other non-metric materials and products will be considered for use the Contractor shall furnish, at the Contractor's expense, evidence satisfactory to the Engineer that the materials and products proposed for use are equal to or better than the materials and products specified or detailed on the plans. The burden of proof as to the quality and suitability of substitutions shall be upon the Contractor and the Contractor shall furnish necessary information as required by the Engineer. The Engineer will be the sole judge as to the quality and suitability of the substituted materials and products and the Engineer's decision will be final.
- C. When the Contractor elects to substitute non-metric materials and products, including materials and products shown on the plans or in the special provisions as being equivalent, the list of sources of material as specified in Section 6-1.01, "Source of Supply and Quality of Materials," of the Standard Specification shall include a list of substitutions to be made and contract items involved. In addition, for a change in design or details the Contractor shall submit plans and working drawings in conformance with the provisions in Section 5-1.02, "Plans and Working Drawings," of the Standard Specifications.

Unless otherwise specified, the following substitutions of materials and products will be allowed:

**SUBSTITUTION TABLE FOR SIZES OF HIGH STRENGTH STEEL FASTENERS**

ASTM Designation: A 325M

METRIC SIZE SHOWN ON THE PLANS mm x thread pitch	IMPERIAL SIZE TO BE SUBSTITUTED inch
M16 x 2	5/8
M20 x 2.5	3/4
M22 x 2.5	7/8
M24 x 3	1
M27 x 3	1-1/8
M30 x 3.5	1-1/4
M36 x 4	1-1/2

**SUBSTITUTION TABLE FOR PLAIN WIRE REINFORCEMENT, ASTM Designation: A 82**

METRIC SIZE SHOWN ON THE PLANS mm <sup>2</sup>	US CUSTOMARY UNITS SIZE TO BE SUBSTITUTED inch <sup>2</sup> x 100
MW9	W1.4
MW10	W1.6
MW13	W2.0
MW15	W2.3
MW19	W2.9
MW20	W3.1
MW22	W3.5
MW25	W3.9, except W3.5 in piles only
MW26	W4.0
MW30	W4.7
MW32	W5.0
MW35	W5.4
MW40	W6.2
MW45	W6.5
MW50	W7.8
MW55	W8.5, except W8.0 in piles only
MW60	W9.3
MW70	W10.9, except W11.0 in piles only
MW80	W12.4
MW90	W14.0
MW100	W15.5

**SUBSTITUTION TABLE FOR BAR REINFORCEMENT**

METRIC BAR DESIGNATION NUMBER SHOWN ON THE PLANS	EQUIVALENT IMPERIAL BAR DESIGNATION NUMBER TO BE SUBSTITUTED
13	4
16	5
19	6
22	7
25	8
29	9
32	10
36	11
43	14
57	18

No adjustment will be required in spacing or total number of reinforcing bars due to a difference in minimum yield strength between metric and non-metric bars.

The sizes in the following tables of materials and products are exact conversions of metric sizes of materials and products and are listed as acceptable equivalents:

CONVERSION TABLE FOR SIZES OF:

- (1) STEEL FASTENERS FOR GENERAL APPLICATIONS, ASTM Designation: A 307 or AASHTO Designation: M 314, Grade 36 or 55, and  
 (2) HIGH STRENGTH STEEL FASTENERS, ASTM Designation: A 325 or A 449

METRIC SIZE SHOWN ON THE PLANS mm	EQUIVALENT IMPERIAL SIZE inch
6, or 6.35	1/4
8 or 7.94	5/16
10, or 9.52	3/8
11, or 11.11	7/16
13 or 12.70	1/2
14, or 14.29	9/16
16, or 15.88	5/8
19, or 19.05	3/4
22, or 22.22	7/8
24, 25, or 25.40	1
29, or 28.58	1-1/8
32, or 31.75	1-1/4
35, or 34.93	1-3/8
38 or 38.10	1-1/2
44, or 44.45	1-3/4
51, or 50.80	2
57, or 57.15	2-1/4
64, or 63.50	2-1/2
70 or 69.85	2-3/4
76, or 76.20	3
83, or 82.55	3-1/4
89 or 88.90	3-1/2
95, or 95.25	3-3/4
102, or 101.60	4

**CONVERSION TABLE FOR NOMINAL THICKNESS OF SHEET METAL**

UNCOATED HOT AND COLD ROLLED SHEETS		HOT-DIPPED ZINC COATED SHEETS (GALVANIZED)	
METRIC THICKNESS SHOWN ON THE PLANS	EQUIVALENT US STANDARD GAGE	METRIC THICKNESS SHOWN ON THE PLANS	EQUIVALENT GALVANIZED SHEET GAGE
mm	inch	mm	inch
7.94	0.3125	4.270	0.1681
6.07	0.2391	3.891	0.1532
5.69	0.2242	3.510	0.1382
5.31	0.2092	3.132	0.1233
4.94	0.1943	2.753	0.1084
4.55	0.1793	2.372	0.0934
4.18	0.1644	1.994	0.0785
3.80	0.1495	1.803	0.0710
3.42	0.1345	1.613	0.0635
3.04	0.1196	1.461	0.0575
2.66	0.1046	1.311	0.0516
2.28	0.0897	1.158	0.0456
1.90	0.0747	1.006 or 1.016	0.0396
1.71	0.0673	0.930	0.0366
1.52	0.0598	0.853	0.0336
1.37	0.0538	0.777	0.0306
1.21	0.0478	0.701	0.0276
1.06	0.0418	0.627	0.0247
0.91	0.0359	0.551	0.0217
0.84	0.0329	0.513	0.0202
0.76	0.0299	0.475	0.0187
0.68	0.0269	-----	-----
0.61	0.0239	-----	-----
0.53	0.0209	-----	-----
0.45	0.0179	-----	-----
0.42	0.0164	-----	-----
0.38	0.0149	-----	-----



**CONVERSION TABLE FOR WIRE**

METRIC THICKNESS SHOWN ON THE PLANS mm	EQUIVALENT USA STEEL WIRE THICKNESS inch	GAGE NO.
6.20	0.244	3
5.72	0.225	4
5.26	0.207	5
4.88	0.192	6
4.50	0.177	7
4.11	0.162	8
3.76	0.148	9
3.43	0.135	10
3.05	0.120	11
2.69	0.106	12
2.34	0.092	13
2.03	0.080	14
1.83	0.072	15
1.57	0.062	16
1.37	0.054	17
1.22	0.048	18
1.04	0.041	19
0.89	0.035	20

**CONVERSION TABLE FOR PIPE PILES**

METRIC SIZE SHOWN ON THE PLANS mm x mm	EQUIVALENT IMPERIAL SIZE inch x inch
PP 360 x 4.55	NPS 14 x 0.179
PP 360 x 6.35	NPS 14 x 0.250
PP 360 x 9.53	NPS 14 x 0.375
PP 360 x 11.12	NPS 14 x 0.438
PP 406 x 12.70	NPS 16 x 0.500
PP 460 x T	NPS 18 x T"
PP 508 x T	NPS 20 x T"
PP 559 x T	NPS 22 x T"
PP 610 x T	NPS 24 x T"
PP 660 x T	NPS 26 x T"
PP 711 x T	NPS 28 x T"
PP 762 x T	NPS 30 x T"
PP 813 x T	NPS 32 x T"
PP 864 x T	NPS 34 x T"
PP 914 x T	NPS 36 x T"
PP 965 x T	NPS 38 x T"
PP 1016 x T	NPS 40 x T"
PP 1067 x T	NPS 42 x T"
PP 1118 x T	NPS 44 x T"
PP 1219 x T	NPS 48 x T"
PP 1524 x T	NPS 60 x T"

The thickness in inches (T") represents an exact conversion of the metric thickness in millimeters (T).

**CONVERSION TABLE FOR STRUCTURAL TIMBER AND LUMBER**

METRIC MINIMUM DRESSED DRY, SHOWN ON THE PLANS mm x mm	METRIC MINIMUM DRESSED GREEN, SHOWN ON THE PLANS mm x mm	EQUIVALENT NOMINAL US SIZE inch x inch
19x89	20x90	1x4
38x89	40x90	2x4
64x89	65x90	3x4
89x89	90x90	4x4
140x140	143x143	6x6
140x184	143x190	6x8
184x184	190x190	8x8
235x235	241x241	10x10
286x286	292x292	12x12

**CONVERSION TABLE FOR NAILS AND SPIKES**

METRIC COMMON NAIL, SHOWN ON THE PLANS  Length, mm Diameter, mm	METRIC BOX NAIL, SHOWN ON THE PLANS  Length, mm Diameter, mm	METRIC SPIKE, SHOWN ON THE PLANS Length, mm Diameter, mm	EQUIVALENT IMPERIAL SIZE  Penny-weight
50.80 2.87	50.80 2.51	————	6d
63.50 3.33	63.50 2.87	————	8d
76.20 3.76	76.20 3.25	76.20 4.88	10d
82.55 3.76	82.55 3.25	82.55 4.88	12d
88.90 4.11	88.90 3.43	88.90 5.26	16d
101.60 4.88	101.60 3.76	101.60 5.72	20d
114.30 5.26	114.30 3.76	114.30 6.20	30d
127.00 5.72	127.00 4.11	127.00 6.68	40d
————	————	139.70 7.19	50d
————	————	152.40 7.19	60d

**CONVERSION TABLE FOR IRRIGATION COMPONENTS**

METRIC WATER METERS, TRUCK LOADING STANDPIPES, VALVES, BACKFLOW PREVENTERS, FLOW SENSORS, WYE STRAINERS, FILTER ASSEMBLY UNITS, PIPE SUPPLY LINES, AND PIPE IRRIGATION SUPPLY LINES SHOWN ON THE PLANS DIAMETER NOMINAL (DN) mm	EQUIVALENT NOMINAL US SIZE inch
15	1/2
20	3/4
25	1
32	1-1/4
40	1-1/2
50	2
65	2-1/2
75	3
100	4
150	6
200	8
250	10
300	12
350	14
400	16

#### **8-1.02 APPROVED TRAFFIC PRODUCTS**

The Department maintains the following list of Approved Traffic Products. The Engineer shall not be precluded from sampling and testing products on the list of Approved Traffic Products.

The manufacturer of products on the list of Approved Traffic Products shall furnish the Engineer a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each type of traffic product supplied.

Signing and delineation materials and products shall not be used in the work unless the material or product is on the list of Approved Traffic Products.

Materials and products may be added to the list of Approved Traffic Products if the manufacturer submits a New Product Information Form to the New Product Coordinator at the Transportation Laboratory. Upon a Departmental request for samples, sufficient samples shall be submitted to permit performance of required tests. Approval of materials or products will depend upon compliance with the specifications and tests the Department may elect to perform.

#### **PAVEMENT MARKERS, PERMANENT TYPE**

##### **Retroreflective**

- A. Apex, Model 921 (100 mm x 100 mm)
- B. Ray-O-Lite, Models SS (100 mm x 100 mm), RS (100 mm x 100 mm) and AA (100 mm x 100 mm)
- C. Stimsonite, Models 88 (100 mm x 100 mm), 911 (100 mm x 100 mm), 953 (70 mm x 114 mm)
- D. 3M Series 290 (89 mm x 100 mm)

##### **Retroreflective With Abrasion Resistant Surface (ARS)**

- A. Ray-O-Lite "AA" ARS (100 mm x 100 mm)
- B. Stimsonite, Models 911 (100 mm x 100 mm), 953 (70 mm x 114 mm)
- C. 3M Series 290 (89 mm x 100 mm)

### **Retroreflective With Abrasion Resistant Surface (ARS)**

(Used for recessed applications)

- A. Stimsonite, Model 948 (58 mm x 119 mm)
- B. Ray-O-Lite, Model 2002 (58 mm x 117 mm)
- C. Stimsonite, Model 944SB (51 mm x 100 mm)\*
- D. Ray-O-Lite, Model 2004 ARS (51 mm x 100 mm)\*

\*For use only in 114 mm wide (older) recessed slots

### **Non-Reflective For Use With Epoxy Adhesive, 100 mm Round**

- A. Apex Universal (Ceramic)
- B. Highway Ceramics, Inc. (Ceramic)

### **Non-Reflective For Use With Bitumen Adhesive, 100 mm Round**

- A. Apex Universal (Ceramic)
- B. Apex Universal, Model 929 (ABS)
- C. Elgin Molded Plastics, "Empco-Lite" Model 900 (ABS)
- D. Highway Ceramics, Inc. (Ceramic)
- E. Hi-Way Safety, Inc., Models P20-2000W and 2001Y (ABS)
- F. Interstate Sales, "Diamond Back" (ABS) and (Polypropylene)
- G. Alpine Products, D-Dot (ABS)
- H. Road Creations, Model RCB4NR (Acrylic)

## **PAVEMENT MARKERS, TEMPORARY TYPE**

### **Temporary Markers For Long Term Day/Night Use (6 months or less)**

- A. Apex Universal, Model 924 (100 mm x 100 mm)
- B. Davidson Plastics Corp., Model 3.0 (100 mm x 100 mm)
- C. Elgin Molded Plastics, "Empco-Lite" Model 901 (100 mm x 100 mm)
- D. Road Creations, Model R41C (100 mm x 100 mm)
- E. Vega Molded Products "Temporary Road Marker" (75 mm x 100 mm)

### **Temporary Markers For Short Term Day/Night Use (14 days or less)**

(For seal coat or chip seal applications, clear protective covers are required)

- A. Apex Universal, Model 932
- B. Davidson Plastics, Models T.O.M., T.R.P.M., and "HH" (High Heat)
- C. Hi-Way Safety, Inc., Model 1280/1281

## **STRIPING AND PAVEMENT MARKING MATERIALS**

### **Permanent Traffic Striping and Pavement Marking Tape**

- A. Advanced Traffic Marking, Series 300 and 400
- B. Brite-Line, Series 1000
- C. Swarco Industries, "Director 35" (For transverse application only)
- D. Swarco Industries, "Director 60"
- E. 3M, "Stamark" Series 380 and 5730
- F. 3M, "Stamark" Series 420 (For transverse application only)

### **Temporary (Removable) Striping and Pavement Marking Tape (6 months or less)**

- A. Brite-Line, Series 100
- B. P.B. Laminations, Aztec, Grade 102
- C. Swarco Industries, "Director-2"
- D. 3M, "Stamark," Series 620
- E. 3M Series A145 Removable Black Line Mask  
(Black Tape: For use only on Asphalt Concrete Surfaces)
- F. Advanced Traffic Marking Black "Hide-A-Line"  
(Black Tape: For use only on Asphalt Concrete Surfaces)

**Preformed Thermoplastic (Heated in place)**

- A. Flint Trading, "Premark" and "Premark 20/20 Flex"
- B. Pavemark, "Hotape"

**Removable Traffic Paint**

- A. Belpro, Series 250/252 and No. 93 Remover

**CLASS 1 DELINEATORS**

**One Piece Driveable Flexible Type, 1700 mm**

- A. Carsonite, Curve-Flex CFRM-400
- B. Carsonite, Roadmarker CRM-375
- C. Davidson Plastics, "Flexi-Guide Models 400 and 566"
- D. FlexStake, Model 654TM
- E. GreenLine Models HWD1-66 and CGD1-66
- F. J. Miller Industries, Model JMI-375 (with soil anchor)

**Special Use Flexible Type, 1700 mm**

- A. Carsonite, "Survivor" (with 450 mm U-Channel base)
- B. FlexStake, Model 604
- C. GreenLine Models HWD and CGD (with 450 mm U-Channel base)
- D. Safe-Hit with 200 mm pavement anchor (SH248-GP1)
- E. Safe-Hit with 380 mm soil anchor (SH248-GP2) and with 450 mm soil anchor (SH248-GP3)

**Surface Mount Flexible Type, 1200 mm**

- A. Bent Manufacturing Company, "Masterflex" Model MF-180EX-48
- B. Carsonite, "Super Duck II"
- C. FlexStake, Surface Mount, Models 704 and 754TM

**CHANNELIZERS**

**Surface Mount Type, 900 mm**

- A. Bent Manufacturing Company, "Masterflex" Models MF-360-36 (Round) and MF-180-36 (Flat)
- B. Carsonite, "Super Duck" (Flat SDF-436, Round SDR-336)
- C. Carsonite, "Super Duck II" Model SDCF203601MB "The Channelizer"
- D. Davidson Plastics, Flex-Guide Models FG300LD and FG300UR
- E. FlexStake, Surface Mount, Models 703 and 753TM
- F. GreenLine, Model SMD-36
- G. Hi-Way Safety, Inc. "Channel Gudie Channelizer" Model CGC36
- H. The Line Connection, "Dura-Post" Model DP36-3 (Permanent)
- I. The Line Connection, "Dura-Post" Model DP36-3C (Temporary)
- J. Repo, Models 300 and 400
- K. Safe-Hit, Guide Post, Model SH236SMA

**CONICAL DELINEATORS, 1070 mm**

(For 700 mm Traffic Cones, see Standard Specifications)

- A. Bent Manufacturing Company "T-Top"
- B. Plastic Safety Systems "Navigator-42"
- C. Roadmaker Company "Stacker"
- D. Traffix Devices "Grabber"

**OBJECT MARKERS**

**Type "K", 450 mm**

- A. Carsonite, Model SMD-615
- B. FlexStake, Model 701KM
- C. Repo, Models 300 and 400
- D. Safe-Hit, Model SH718SMA
- E. The Line Connection, Model DP21-4K

**Type "K-4" / "Q", 600 mm**

(Shown as Type "Q" in the Traffic Manual)

- A. Bent Manufacturing "Masterflex" Model MF-360-24
- B. Carsonite, Super Duck II
- C. FlexStake, Model 701KM
- D. Repo, Models 300 and 400
- E. Safe-Hit, Models SH8 24SMA\_WA and SH8 24GP3\_WA
- F. The Line Connection, Model DP21-4Q

**TEMPORARY RAILING (TYPE K) REFLECTORS AND CONCRETE BARRIER MARKERS**

**Impactable Type**

- A. ARTUK, "FB"
- B. Davidson Plastics, Model PCBM-12
- C. Duraflex Corp., "Flexx 2020" and "Electriflexx"
- D. Hi-Way Safety, Inc., Model GMKRM100

**Non-Impactable Type**

- A. ARTUK, JD Series
- B. Stimsonite, Model 967 (with 83 mm Acrylic cube corner reflector)
- C. Stimsonite, Model 967LS
- D. Vega Molded Products, Models GBM and JD

**THREE BEAM BARRIER MARKERS**

(For use to the left of traffic)

- A. Duraflex Corp., "Railrider"
- B. Davidson Plastics, "Mini" (75 mm x 254 mm)

**CONCRETE BARRIER DELINEATORS, 400 mm**

(For use to the right of traffic. When mounted on top of barrier, places top of reflective element at 1200 mm)

- A. Davidson Plastics, Model PCBM T-16
- B. Safe-Hit, Model SH216RBM

**CONCRETE BARRIER-MOUNTED MINI-DRUM (260 mm x 360 mm x 570 mm)**

- A. Stinson Equipment Company "SaddleMarker"

**SOUND WALL DELINEATOR**

(Applied to a vertical surface. Top of reflective element at 1200 mm)

- A. Davidson Plastics, PCBM S-36

**GUARD RAILING DELINEATOR**

(Top of reflective element at 1200 mm above plane of roadway)

**Wood Post Type, 686 mm**

- A. Carsonite, Model 427
- B. Davidson Plastics FG 427 and FG 527
- C. FlexStake, Model 102 GR
- D. GreenLine GRD 27
- E. J. Miller Model JMI-375G
- F. Safe-Hit, Model SH227GRD

**Steel Post Type**

- A. Carsonite, Model CFGR-327 with CFGRBK300 Mounting Bracket

**RETROREFLECTIVE SHEETING**

**Channelizers, Barrier Markers, and Delineators**

- A. 3M, High Intensity
- B. Reflexite, PC-1000 Metalized Polycarbonate
- C. Reflexite, AC-1000 Acrylic

- D. Reflexite, AP-1000 Metalized Polyester
- E. Reflexite, AR-1000 Abrasion Resistant Coating
- F. Stimsonite, Series 6200 (For rigid substrate devices only)

**Traffic Cones, 330 mm Sleeves**

- A. Reflexite SB (Polyester), Vinyl or "TR" (Semi-transparent)

**Traffic Cones, 100 mm and 150 mm Sleeves**

- A. 3M Series 3840
- B. Reflexite Vinyl, "TR" (Semi-transparent) or "Conformalite"

**Barrels and Drums**

- A. Reflexite, "Super High Intensity" or "High Impact Drum Sheeting"
- B. 3M Series 3810

**Barricades: Type I, Engineer Grade**

- A. American Decal, Adcolite
- B. Avery Dennison, 1500 and 1600
- C. 3M, Scotchlite, Series CW

**Barricades: Type II, Super Engineer Grade**

- A. Avery Dennison, "Fasign" 2500 Series
- B. Kiwalite Type II
- C. Nikkalite 1800 Series

**Signs: Type II, Super Engineer Grade**

- A. Avery Dennison, "Fasign" 2500 Series
- B. Kiwalite, Type II
- C. Nikkalite 1800 Series

**Signs: Type III, High-Intensity Grade**

- A. 3M Series 3800
- B. Nippon Carbide, Nikkalite Brand Ultralite Grade II

**Signs: Type IV, High-Intensity Prismatic Grade**

- A. Stimsonite Series 6200

**Signs: Type VII, High-Intensity Prismatic Grade**

- A. 3M Series 3900

**Signs: Type VI, Roll-Up Signs**

- A. Reflexite, Vinyl (Orange), Reflexite "SuperBright" (Fluorescent orange)
- B. 3M Series RS34 (Orange) and RS20 (Fluorescent orange)

**SIGN SUBSTRATE FOR CONSTRUCTION AREA SIGNS**

**Aluminum**

**Fiberglass Reinforced Plastic (FRP)**

- A. Sequentia, "Polyplate"
- B. Fiber-Brite

**8-1.03 STATE-FURNISHED MATERIALS**

Attention is directed to Section 6-1.02, "State-Furnished Materials," of the Standard Specifications and these special provisions.

The following materials will be furnished to the Contractor:

- A. Loop detector sensor units.
- B. Model 170 controller assemblies, including controller unit, completely wired controller cabinet, and inductive loop detector sensor units.

The Contractor shall notify the Engineer not less than 48 hours before State-furnished material is to be picked up by the Contractor. A full description of the material and the time the material will be picked up shall be provided. State-furnished controller assembly will be furnished to the Contractor at the Department of Transportation Redistribution Warehouse located at 175 Cluster Street, San Bernardino, California.

## **SECTION 8-2. CONCRETE**

### **8-2.01 PORTLAND CEMENT CONCRETE**

Portland cement concrete shall conform to the provisions in Section 90, "Portland Cement Concrete," of the Standard Specifications and these special provisions.

Unless the use of a mineral admixture is prohibited, whenever the word "cement" is used in the Standard Specifications or the special provisions, it shall be understood to mean "cementitious material" when both of the following conditions are met:

- A. The cement content of portland cement concrete is specified, and
- B. Section 90, "Portland Cement Concrete," of the Standard Specifications is referenced.

Section 90-1.01, "Description," of the Standard Specifications is amended to read:

#### **90-1.01 DESCRIPTION**

- Portland cement concrete shall be composed of cementitious material, fine aggregate, coarse aggregate, admixtures if used, and water, proportioned and mixed as specified in these specifications.
- Unless otherwise specified, cementitious material to be used in portland cement concrete shall conform to the provisions for cement and mineral admixtures in Section 90-2, "Materials," and shall be either: 1) "Type IP (MS) Modified" cement or 2) a combination of "Type II Modified" portland cement and mineral admixture.
- Concrete for each portion of the work shall comply with the provisions for the Class, cementitious material content in kilograms per cubic meter, 28-day compressive strength, minor concrete or commercial quality concrete, as shown on the plans or specified in these specifications or the special provisions.
  - Class 1 concrete shall contain not less than 400 kg of cementitious material per cubic meter.
  - Class 2 concrete shall contain not less than 350 kg of cementitious material per cubic meter.
  - Class 3 concrete shall contain not less than 300 kg of cementitious material per cubic meter.
  - Class 4 concrete shall contain not less than 250 kg of cementitious material per cubic meter.
  - Minor concrete shall contain not less than 325 kg of cementitious material per cubic meter unless otherwise specified in these specifications or the special provisions.
- Unless otherwise designated on the plans or specified in these specifications or the special provisions, the amount of cementitious material used per cubic meter of concrete in structures or portions of structures shall conform to the following:

Use	Cementitious Material Content (kg/m <sup>3</sup> )
Concrete which is designated by compressive strength:	
Deck slabs and slab spans of bridges	400 min., 475 max.
Roof sections of exposed top box culverts	400 min., 475 max.
Other portions of structures	350 min., 475 max.
Concrete not designated by compressive strength:	
Deck slabs and slab spans of bridges	400 min.
Roof sections of exposed top box culverts	400 min.
Prestressed members	400 min.
Seal courses	400 min.
Other portions of structures	350 min.
Concrete for precast members	350 min., 550 max.



- Whenever the 28-day compressive strength shown on the plans is greater than 25 MPa, the concrete shall be considered to be designated by compressive strength. If the plans show a 28-day compressive strength which is 31 MPa or greater, an additional 7 days will be allowed to obtain the specified strength. The 28-day compressive strengths shown on the plans which are 25 MPa or less are shown for design information only and are not to be considered a requirement for acceptance of the concrete.

- Concrete designated by compressive strength shall be proportioned such that the concrete will conform to the strength shown on the plans or specified in the special provisions.

- The Contractor shall determine the mix proportions for all concrete.

- Before using concrete for which the mix proportions have been determined by the Contractor, or in advance of revising those mix proportions, the Contractor shall submit in writing to the Engineer a copy of the mix design.

- Compliance with cementitious material content requirements will be verified in conformance with procedures described in California Test 518 for cement content. For testing purposes, mineral admixture shall be considered to be cement. Batch proportions shall be adjusted as necessary to produce concrete having the specified cementitious material content.

- If any concrete used in the work has a cementitious material content, consisting of cement, mineral admixture, or cement plus mineral admixture, which is less than the minimum required for the work, the concrete shall be removed. However, if the Engineer determines that the concrete is structurally adequate, the concrete may remain in place and the Contractor shall pay to the State \$0.55 for each kilogram of cement, mineral admixture, or cement plus mineral admixture which is less than the minimum required for the work. The Department may deduct the amount from moneys due, or that may become due, the Contractor under the contract. The deductions will not be made unless the difference between the contents required and those actually provided exceeds the batching tolerances permitted by Section 90-5, "Proportioning." No deductions for cementitious material content will be made based on the results of California Test 518.

- The requirements of the preceding paragraph shall not apply to minor concrete or commercial quality concrete.

- Concrete for which the mix proportions are determined either by the Contractor or the Engineer shall conform to the requirements of this Section 90.

The first paragraph in Section 90-2.01, "Portland Cement," of the Standard Specifications is amended to read:

#### **90-2.01 PORTLAND CEMENT**

- Unless otherwise specified, portland cement shall be either "Type IP (MS) Modified" cement or "Type II Modified" portland cement.

- "Type IP (MS) Modified" cement shall conform to the specifications for Type IP (MS) cement in ASTM Designation: C 595, and shall be comprised of an intimate mixture of Type II cement and not more than 25 percent of a mineral admixture. The type and minimum amount of mineral admixture used in the manufacture of "Type IP (MS) Modified" cement shall be in conformance with the provisions in Section 90-4.08, "Required Use of Mineral Admixtures."

- "Type II Modified" portland cement shall conform to the requirements for Type II portland cement in ASTM Designation: C 150.

- In addition, "Type IP (MS) Modified" cement and "Type II Modified" portland cement shall conform to the following requirements:

A. The cement shall not contain more than 0.60 percent by mass of alkalis, calculated as the percentage of Na<sub>2</sub>O plus 0.658 times the percentage of K<sub>2</sub>O, when determined by either direct intensity flame photometry or by the atomic absorption method. The instrument and procedure used shall be qualified as to precision and accuracy in conformance with the requirements in ASTM Designation: C 114.

B. The autoclave expansion shall not exceed 0.50 percent.

C. Mortar, containing the cement to be used and Ottawa sand, when tested in conformance with California Test 527, shall not expand in water more than 0.010 percent and shall not contract in air more than 0.048 percent except that when cement is to be used for precast prestressed concrete piling, precast prestressed concrete members or steam cured concrete products, the mortar shall not contract in air more than 0.053 percent.

The second paragraph in Section 90-2.01, "Portland Cement," of the Standard Specifications is amended to read:

- Type III and Type V portland cements shall conform to the requirements in ASTM Designation: C 150, and the additional requirements listed above for Type II Modified portland cement, except that when tested in conformance with California Test 527, mortar containing Type III portland cement shall not contract in air more than 0.075 percent.

The third paragraph in Section 90-2.01, "Portland Cement," of the Standard Specifications is deleted.

The twelfth paragraph in Section 90-2.02, "Aggregates," of the Standard Specifications is deleted.

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The first paragraph in Section 90-2.03, "Water," of the Standard Specifications is amended to read:

#### **90-2.03 WATER**

- In conventionally reinforced concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 1,000 parts per million of chlorides as Cl, nor more than 1,300 parts per million of sulfates as SO<sub>4</sub>. In prestressed concrete work, the water for curing, for washing aggregates, and for mixing shall be free from oil and shall not contain more than 650 parts per million of chlorides as Cl, nor more than 1,300 parts per million of sulfates as SO<sub>4</sub>. In no case shall the water contain an amount of impurities that will cause either: 1) a change in the setting time of cement of more than 25 percent when tested in conformance with the requirements in ASTM Designation: C 191 or ASTM Designation: C 266 or 2) a reduction in the compressive strength of mortar at 14 days of more than 5 percent, when tested in conformance with the requirements in ASTM Designation: C 109, when compared to the results obtained with distilled water or deionized water, tested in conformance with the requirements in ASTM Designation: C 109.

The following section is added to Section 90-2, "Materials," of the Standard Specifications:

#### **90-2.04 ADMIXTURE MATERIALS**

- Admixture materials shall conform to the requirements in the following ASTM Designations:
  - A. Chemical Admixtures—ASTM Designation: C 494.
  - B. Air-entraining Admixtures—ASTM Designation: C 260.
  - C. Calcium Chloride—ASTM Designation: D 98.
  - D. Mineral Admixtures—Coal fly ash, raw or calcined natural pozzolan as specified in ASTM Designation: C 618. Silica fume conforming to the requirements in ASTM Designation: C 1240, with reduction of mortar expansion of 80 percent, minimum, using the cement from the proposed mix design.
- Mineral admixtures shall be used in conformance with the provisions in Section 90-4.08, "Required Use of Mineral Admixtures."

Section 90-4.02, "Materials," of the Standard Specifications is amended to read:

#### **90-4.02 MATERIALS**

- Admixture materials shall conform to the provisions in Section 90-2.04, "Admixture Materials."

Section 90-4.05, "Optional Use of Chemical Admixtures," of the Standard Specifications is amended to read:

#### **90-4.05 OPTIONAL USE OF CHEMICAL ADMIXTURES**

- The Contractor will be permitted to use Type A or F, water-reducing; Type B, retarding; or Type D or G, water-reducing and retarding admixtures as described in ASTM Designation: C 494 to conserve cementitious material or to facilitate concrete construction application subject to the following conditions:
  - A. When a water-reducing admixture or a water-reducing and retarding admixture is used, the cementitious material content specified or ordered may be reduced by a maximum of 5 percent by mass except that the resultant cementitious material content shall be not less than 300 kilograms per cubic meter.
  - B. When a reduction in cementitious material content is made, the dosage of admixture used shall be the dosage used in determining approval of the admixture.

Section 90-4.07, "Optional Use of Air-entraining Admixtures," of the Standard Specifications is amended to read:

#### **90-4.07 OPTIONAL USE OF AIR-ENTRAINING ADMIXTURES**

- When air-entrainment has not been specified or ordered by the Engineer, the Contractor will be permitted to use an air-entraining admixture to facilitate the use of any construction procedure or equipment provided that the average air content, as determined by California Test 504, of 3 successive tests does not exceed 4 percent and no single test value exceeds 5.5 percent. If the Contractor elects to use an air-entraining admixture in concrete for pavement, the Contractor shall so indicate at the time the Contractor designates the source of aggregate as provided in Section 40-1.015, "Cement Content."

Section 90-4.08, "Required Use of Mineral Admixtures," of the Standard Specifications is amended to read:

**90-4.08 REQUIRED USE OF MINERAL ADMIXTURES**

- Unless otherwise specified, mineral admixture shall be combined with cement to make cementitious material for use in portland cement concrete.
- The calcium oxide content of mineral admixtures shall not exceed 10 percent and the available alkali, as sodium oxide equivalent, shall not exceed 1.5 percent when determined in conformance with the requirements in ASTM Designation: C618.
- The amounts of cement and mineral admixture used in cementitious material for portland cement concrete shall be sufficient to satisfy the minimum cementitious material content requirements specified in Section 90-1.01, "Description," or Section 90-4.05, "Optional Use of Chemical Admixtures," and shall conform to the following:
  - A. The minimum amount of cement shall not be less than 75 percent by mass of the specified minimum cementitious material content.
  - B. The minimum amount of mineral admixture to be combined with cement shall be determined using one of the following criteria:
    1. When the calcium oxide content of a mineral admixture, as determined in conformance with the requirements in ASTM Designation: C618 and the provisions in Section 90-2.04, "Admixture Materials," is equal to or less than 2 percent by mass, the amount of mineral admixture shall not be less than 15 percent by mass of the total amount of cementitious material to be used in the mix.
    2. When the calcium oxide content of a mineral admixture, as determined in conformance with the requirements in ASTM Designation: C618 and the provisions in Section 90-2.04, "Admixture Materials," is greater than 2 percent, the amount of mineral admixture shall not be less than 25 percent by mass of the total amount of cementitious material to be used in the mix.
    3. When a mineral admixture is used, which conforms to the provisions for silica fume in Section 90-2.04, "Admixture Materials," the amount of mineral admixture shall not be less than 10 percent by mass of the total amount of cementitious material to be used in the mix.
  - C. If more than the required amount of cementitious material is used, the additional cementitious material in the mix may be either cement, a mineral admixture conforming to the provisions in Section 90-2.04, "Admixture Materials," or a combination of both; however, the maximum total amount of mineral admixture shall not exceed 35 percent by mass of the total amount of cementitious material to be used in the mix. Where Section 90-1.01, "Description," specifies a maximum cementitious content in kilograms per cubic meter, the total mass of cement and mineral admixture per cubic meter shall not exceed the specified maximum cementitious material content.

Section 90-4.09, "Optional Use of Mineral Admixtures," of the Standard Specifications is deleted.

Section 90-4.11, "Storage, Proportioning, and Dispensing of Mineral Admixtures," of the Standard Specifications is amended to read:

**90-4.11 STORAGE, PROPORTIONING, AND DISPENSING OF MINERAL ADMIXTURES**

- Mineral admixtures shall be protected from exposure to moisture until used. Sacked material shall be piled to permit access for tally, inspection, and identification for each shipment.
- Adequate facilities shall be provided to assure that mineral admixtures meeting the specified requirements are kept separate from other mineral admixtures in order to prevent any but the specified mineral admixtures from entering the work. Safe and suitable facilities for sampling mineral admixtures shall be provided at the weigh hopper or in the feed line immediately in advance of the hopper.
- Mineral admixtures shall be incorporated into concrete using equipment conforming to the requirements for cement weigh hoppers, and charging and discharging mechanisms in ASTM Designation: C 94, in Section 90-5.03, "Proportioning," and in this Section 90-4.11.
- When interlocks are required for cement and mineral admixture charging mechanisms by Section 90-5.03A, "Proportioning for Pavement," and cement and mineral admixtures are weighed cumulatively, their charging mechanisms shall be interlocked to prevent the introduction of mineral admixture until the mass of cement in the cement weigh hopper is within the tolerances specified in Section 90-5.02, "Proportioning Devices."
- Mineral admixture used in concrete for exposed surfaces of like elements of a structure shall be from the same source and of the same percentage.

Section 90-5.02, "Proportioning Devices," of the Standard Specifications is amended to read:

#### **90-5.02 PROPORTIONING DEVICES**

- Weighing, measuring or metering devices used for proportioning materials shall conform to the provisions in Section 9-1.01, "Measurement of Quantities," and this Section 90-5.02. In addition, automatic weighing systems used shall comply with the provisions for automatic proportioning devices in Section 90-5.03A, "Proportioning for Pavement." These automatic devices shall be automatic to the extent that the only manual operation required for proportioning the aggregates, cement, and mineral admixture for one batch of concrete is a single operation of a switch or starter.

- Proportioning devices shall be tested at the expense of the Contractor as frequently as the Engineer may deem necessary to insure their accuracy.

- Weighing equipment shall be insulated against vibration or movement of other operating equipment in the plant. When the plant is in operation, the mass of each batch of material shall not vary from the mass designated by the Engineer by more than the tolerances specified herein.

- Equipment for cumulative weighing of aggregate shall have a zero tolerance of  $\pm 0.5$  percent of the designated total batch mass of the aggregate. For systems with individual weigh hoppers for the various sizes of aggregate, the zero tolerance shall be  $\pm 0.5$  percent of the individual batch mass designated for each size of aggregate. Equipment for cumulative weighing of cement and mineral admixtures shall have a zero tolerance of  $\pm 0.5$  percent of the designated total batch mass of the cement and mineral admixture. Equipment for weighing cement or mineral admixture separately shall have a zero tolerance of  $\pm 0.5$  percent of their designated individual batch masses. Equipment for measuring water shall have a zero tolerance of  $\pm 0.5$  percent of its designated mass or volume.

- The mass indicated for a batch of material shall not vary from the preselected scale setting by more than the following:

- A. Aggregate weighed cumulatively shall be within 1.0 percent of the designated total batch mass of the aggregate. Aggregates weighed individually shall be within 1.5 percent of their respective designated batch masses.
- B. Cement shall be within 1.0 percent of its designated batch mass. When weighed individually, mineral admixture shall be within 1.0 percent of its designated batch mass. When mineral admixture and cement are permitted to be weighed cumulatively, cement shall be weighed first to within 1.0 percent of its designated batch mass, and the total for cement and mineral admixture shall be within 1.0 percent of the sum of their designated batch masses.
- C. Water shall be within 1.5 percent of its designated mass or volume.

- Each scale graduation shall be approximately 0.001 of the total capacity of the scale. The capacity of scales for weighing cement, mineral admixture, or cement plus mineral admixture and aggregates shall not exceed that of commercially available scales having single graduations indicating a mass not exceeding the maximum permissible mass variation above, except that no scale shall be required having a capacity of less than 500 kg, with 0.5 kg graduations.

Section 90-5.03, "Proportioning," excluding Section 90-5.03A, "Proportioning for Pavement," of the Standard Specifications is amended to read:

#### **90-5.03 PROPORTIONING**

- Proportioning shall consist of dividing the aggregates into the specified sizes, each stored in a separate bin, and combining them with cement, mineral admixture, and water as provided in these specifications. Aggregates shall be proportioned by mass.

- At the time of batching, aggregates shall have been dried or drained sufficiently to result in a stable moisture content such that no visible separation of water from aggregate will take place during transportation from the proportioning plant to the point of mixing. In no event shall the free moisture content of the fine aggregate at the time of batching exceed 8 percent of its saturated, surface-dry mass.

- Should separate supplies of aggregate material of the same size group, but of different moisture content or specific gravity or surface characteristics affecting workability, be available at the proportioning plant, withdrawals shall be made from one supply exclusively and the materials therein completely exhausted before starting upon another.

- Bulk "Type IP (MS) Modified" cement that conforms to the provisions in Section 90-2.01, "Portland Cement," shall be weighed in an individual hopper and shall be kept separate from the aggregates until the ingredients are released for discharge into the mixer.

- Bulk cement to be blended with mineral admixture for use in portland cement concrete for pavement and structures may be weighed in separate, individual weigh hoppers or may be weighed in the same weigh hopper with mineral admixture and shall be kept separate from the aggregates until the ingredients are released for discharge into the mixer. If the cement and mineral admixture are weighed cumulatively, the cement shall be weighed first.

- When cement and mineral admixtures are weighed in separate weigh hoppers, the weigh systems for the proportioning of the aggregate, the cement, and the mineral admixture shall be individual and distinct from other weigh systems. Each weigh system shall be equipped with a hopper, a lever system, and an indicator to constitute an individual and independent material weighing device. The cement and the mineral admixture shall be discharged into the mixer simultaneously with the aggregate.

- The scale and weigh hopper for bulk weighing cement, mineral admixture, and cement plus mineral admixture shall be separate and distinct from the aggregate weighing equipment.

- When the source of an aggregate is changed for concrete structures, the Contractor shall adjust the mix proportions and submit in writing to the Engineer a copy of the mix design before using such aggregates. When the source of an aggregate is changed for other concrete, the Engineer shall be allowed sufficient time to adjust the mix and such aggregates shall not be used until necessary adjustments are made.

- For batches with a volume of one cubic meter or more, the batching equipment shall conform to one of the following combinations:

- A. Separate boxes and separate scale and indicator for weighing each size of aggregate.
- B. Single box and scale indicator for all aggregates.
- C. Single box or separate boxes and automatic weighing mechanism for all aggregates.

- In order to check the accuracy of batch masses, the gross mass and tare mass of batch trucks, truck mixers, truck agitators, and non-agitating hauling equipment shall be determined when ordered by the Engineer. The equipment shall be weighed at the Contractor's expense on scales designated by the Engineer.

The third paragraph in Section 90-6.01, "General," of the Standard Specifications is amended to read:

- Concrete shall be homogeneous and thoroughly mixed. There shall be no lumps or evidence of undispersed cement, mineral admixture, or cement plus mineral admixture.

The third and fourth paragraphs in Section 90-6.02, "Machine Mixing," of the Standard Specifications are amended to read:

- The batch shall be so charged into the mixer that some water will enter in advance of cementitious materials and aggregates. All water shall be in the drum by the end of the first one-fourth of the specified mixing time.

- Cementitious materials shall be batched and charged into the mixer by means that will not result either in loss of cementitious materials due to the effect of wind, or in accumulation of cementitious materials on surfaces of conveyors or hoppers, or in other conditions which reduce or vary the required quantity of cementitious material in the concrete mixture.

The sixth paragraph in Section 90-6.02, "Machine Mixing," of the Standard Specifications is amended to read:

- The total elapsed time between the intermingling of damp aggregates and all cementitious materials and the start of mixing shall not exceed 30 minutes.

The seventh through tenth paragraphs in Section 90-6.03, "Transporting Mixed Concrete," of the Standard Specifications are amended to read:

- When a truck mixer or agitator is used for transporting concrete to the delivery point, discharge shall be completed within 1.5 hours, or before 250 revolutions of the drum or blades, whichever comes first, after the introduction of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 30°C, or above, a time less than 1.5 hours may be required.

- When non-agitating hauling equipment is used for transporting concrete to the delivery point, discharge shall be completed within one hour after the addition of the cement to the aggregates. Under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 30°C, or above, the time between the introduction of cement to the aggregates and discharge shall not exceed 45 minutes.

- Each load of concrete delivered at the job site shall be accompanied by a weight certificate showing the mix identification number, non-repeating load number, date and time at which the materials were batched, the total amount of water added to the load and for transit-mixed concrete, the reading of the revolution counter at the time the truck mixer is charged with cement. This weight certificate shall also show the actual scale masses (kilograms) for the ingredients batched. Theoretical or target batch masses shall not be used as a substitute for actual scale masses.

- Weight certificates shall be provided in printed form, or if approved by the Engineer, the data may be submitted in electronic media. Electronic media shall be presented in a tab-delimited format on 90 mm diskette with a capacity of at least 1.4 megabytes. Captured data, for the ingredients represented by each batch shall be LFCR (one line, separate record) with allowances for sufficient fields to satisfy the amount of data required by these specifications.
- The Contractor may furnish a weight certificate that is accompanied by a separate certificate which lists the actual batch masses or measurements for a load of concrete provided that both certificates are 1) imprinted with the same non-repeating load number that is unique to the contract and 2) delivered to the job site with the load.
- Weight certificates furnished by the Contractor shall conform to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.

Section 90-6.05, "Hand-Mixing," of the Standard Specifications is amended to read:

#### **90-6.05 HAND-MIXING**

- Hand-mixed concrete shall be made in batches not more than one-fourth cubic meter and shall be mixed on a watertight, level platform. The proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform and the fine aggregate shall be spread on this layer, the 2 layers being not more than 0.3 meters in total depth. On this mixture shall be spread the dry cement and mineral admixture and the whole mass turned no fewer than 2 times dry; then sufficient clean water shall be added, evenly distributed, and the whole mass again turned no fewer than 3 times, not including placing in the carriers or forms.

The table in the first paragraph in Section 90-6.06, "Amount of Water and Penetration," of the Standard Specifications is replaced with the following table:

Type of Work	Nominal Penetration (mm)	Maximum Penetration (mm)
Concrete pavement	0-25	40
Non-reinforced concrete facilities	0-35	50
Reinforced concrete structures:		
Sections over 300 mm thick	0-35	65
Sections 300 mm thick or less	0-50	75
Concrete placed under water	75-100	115
Cast-in-place concrete piles	65-90	100

The first paragraph following the table of penetration ranges in Section 90-6.06, "Amount of Water and Penetration," of the Standard Specifications is amended to read:

- The amount of free water used in concrete shall not exceed 183 kg/m<sup>3</sup>, plus 20 kg for each required 100 kg of cementitious material in excess of 325 kg/m<sup>3</sup>.

The fourth paragraph in Section 90-6.06, "Amount of Water and Penetration," of the Standard Specifications is amended to read:

- Where there are adverse or difficult conditions which affect the placing of concrete, the above specified penetration and free water content limitations may be exceeded providing the Contractor is granted permission by the Engineer in writing to increase the cementitious material content per cubic meter of concrete. The increase in water and cementitious material shall be at a ratio not to exceed 30 kg of water per added 100 kg of cementitious material per cubic meter. The cost of additional cementitious material and water added under these conditions shall be at the Contractor's expense and no additional compensation will be allowed therefor.

Section 90-9.01, "General," of the Standard Specifications is amended to read:

#### **90-9.01 GENERAL**

- Concrete compressive strength requirements consist of a minimum strength which must be attained before various loads or stresses are applied to the concrete and, for concrete designated by strength, a minimum strength at the age of 28 days or at the age otherwise allowed in Section 90-1.01, "Description." The various strengths required are specified in these specifications or are shown on the plans.

- The compressive strength of concrete will be determined from test cylinders which have been fabricated from concrete sampled in conformance with California Test 539. Test cylinders will be molded and initial field cured in conformance with California Test 540. Test cylinders will be cured and tested after receipt at the testing laboratory in conformance with California Test 521. A strength test shall consist of the average strength of 2 cylinders fabricated from material taken from a single load of concrete, except that, if any cylinder should show evidence of improper sampling, molding, or testing, that cylinder shall be discarded and the strength test shall consist of the strength of the remaining cylinder.

- When concrete compressive strength is specified as a prerequisite to applying loads or stresses to a concrete structure or member, test cylinders for other than steam cured concrete will be cured in conformance with Method 1 of California Test 540. The compressive strength of concrete determined for these purposes will be evaluated on the basis of individual tests.

- When concrete is designated by 28-day compressive strength rather than by cementitious material content, the concrete strength to be used as a basis for acceptance of other than steam cured concrete will be determined from cylinders cured in conformance with Method 1 of California Test 540. If the result of a single compressive strength test at the maximum age specified or allowed is below the specified strength but is 95 percent or more of the specified strength, the Contractor shall, at the Contractor's expense, make corrective changes, subject to approval by the Engineer, in the mix proportions or in the concrete fabrication procedures, before placing additional concrete, and shall pay to the State \$14 for each in-place cubic meter of concrete represented by the deficient test. If the result of a single compressive strength test at the maximum age specified or allowed is below 95 percent of the specified strength, but is 85 percent or more of the specified strength, the Contractor shall make the corrective changes specified above, and shall pay to the State \$20 for each in place cubic meter of concrete represented by the deficient test. In addition, such corrective changes shall be made when the compressive strength of concrete tested at 7 days indicates, in the judgment of the Engineer, that the concrete will not attain the required compressive strength at the maximum age specified or allowed. Concrete represented by a single test which indicates a compressive strength of less than 85 percent of the specified 28-day compressive strength will be rejected in conformance with the provisions in Section 6-1.04, "Defective Materials."

- If the test result indicates that the compressive strength at the maximum curing age specified or allowed is below the specified strength, but 85 percent or more of the specified strength, payments to the State as required above shall be made, unless the Contractor, at the Contractor's expense, obtains and submits evidence acceptable to the Engineer that the strength of the concrete placed in the work meets or exceeds the specified 28-day compressive strength. If the test result indicates a compressive strength at the maximum curing age specified or allowed below 85 percent, the concrete represented by that test will be rejected, unless the Contractor, at the Contractor's expense, obtains and submits evidence acceptable to the Engineer that the strength and quality of the concrete placed in the work are acceptable. If the evidence consists of tests made on cores taken from the work, the cores shall be obtained and tested in conformance with the requirements in ASTM Designation: C 42.

- No single compressive strength test shall represent more than 250 cubic meters.

- When a precast concrete member is steam cured, the compressive strength of the concrete will be determined from test cylinders which have been handled and stored in conformance with Method 3 of California Test 540. The compressive strength of steam cured concrete will be evaluated on the basis of individual tests representing specific portions of production. When the concrete is designated by 28-day compressive strength rather than by cementitious material content, the concrete shall be considered to be acceptable whenever its compressive strength reaches the specified 28-day compressive strength provided that strength is reached in not more than the maximum number of days specified or allowed after the member is cast.

- If concrete is specified by compressive strength, then materials, mix proportions, mixing equipment, and procedures proposed for use shall be prequalified prior to placement of the concrete. Prequalification shall be accomplished by the submission of acceptable certified test data or trial batch reports by the Contractor. Prequalification data shall be based on the use of materials, mix proportions, mixing equipment, procedures, and size of batch proposed for use in the work.

- Certified test data, in order to be acceptable, must indicate that not less than 90 percent of at least 20 consecutive tests exceed the specified strength at the maximum number of cure days specified or allowed, and none of those tests are less than 95 percent of specified strength. Strength tests included in the data shall be the most recent tests made on concrete of the proposed mix design and all shall have been made within one year of the proposed use of the concrete.

- Trial batch test reports, in order to be acceptable, must indicate that the average compressive strength of 5 consecutive concrete cylinders, taken from a single batch, at not more than 28 days (or the maximum age allowed) after molding shall be at least 4 MPa greater than the specified 28-day compressive strength, and no individual cylinder shall have a strength less than the specified strength at the maximum age specified or allowed. Data contained in the report shall be from trial batches which were produced within one year of the proposed use of specified strength concrete in the project. Whenever air-entrainment is required, the air content of trial batches shall be equal to or greater than the air content specified for the concrete without reduction due to tolerances.

- Tests shall be performed in conformance with either the appropriate California Test methods or the comparable ASTM test methods. Equipment employed in testing shall be in good condition and shall be properly calibrated. If the tests are performed during the life of the contract, the Engineer shall be notified sufficiently in advance of performing the tests in order to witness the test procedures.

- The certified test data and trial batch test reports shall include the following information:

- A. Date of mixing.
- B. Mixing equipment and procedures used.
- C. The size of batch in cubic meters and the mass, type and source of ingredients used.
- D. Penetration of the concrete.
- E. The air content of the concrete if an air-entraining admixture is used.
- F. The age at time of testing and strength of concrete cylinders tested.

- Certified test data and trial batch test reports shall be signed by an official of the firm which performed the tests.

- When approved by the Engineer, concrete from trial batches may be used in the work at locations where concrete of a lower quality is required and the concrete will be paid for as the type or class of concrete required at that location.

- After materials, mix proportions, mixing equipment, and procedures for concrete have been prequalified for use, additional prequalification by testing of trial batches will be required prior to making changes which, in the judgment of the Engineer, could result in a lowering of the strength of the concrete below that specified.

- The Contractor's attention is directed to the time required to test trial batches. The Contractor shall be responsible for production of trial batches at a sufficiently early date so that the progress of the work is not delayed.

- When precast concrete members are manufactured at the plant of an established manufacturer of precast concrete members, the mix proportions of the concrete shall be determined by the Contractor, and a trial batch and prequalification of the materials, mix proportions, mixing equipment, and procedures will not be required.

Section 90-10.02A, "Portland Cement," of the Standard Specifications is renamed "Cementitious Material" and is amended to read:

#### **90-10.02A CEMENTITIOUS MATERIAL**

- Cementitious material shall conform to the provisions in Section 90-1.01, "Description." Compressive strength requirements consist of a minimum strength which must be attained before various loads or stresses are applied to the concrete and, for concrete designated by strength, a minimum strength at the age of 28 days or at the age otherwise allowed in Section 90-1.01, "Description." The various strengths required are specified in these specifications or are shown on the plans.

The fifth paragraph in Section 90-10.02B, "Aggregate," of the Standard Specifications is deleted.

Section 90-10.03, "Production," of the Standard Specifications is amended to read:

#### **90-10.03 PRODUCTION**

- Cementitious material, water, aggregate, and admixtures shall be stored, proportioned, mixed, transported, and discharged in conformance with recognized standards of good practice, which will result in concrete that is thoroughly and uniformly mixed, which is suitable for the use intended, and which conforms to provisions specified herein. Recognized standards of good practice are outlined in various industry publications such as those issued by American Concrete Institute, AASHTO, or California Department of Transportation.

- The cementitious material content of minor concrete shall conform to the provisions in Section 90-1.01, "Description."

- The amount of water used shall result in a consistency of concrete conforming to the provisions in Section 90-6.06, "Amount of Water and Penetration." Additional mixing water shall not be incorporated into the concrete during hauling or after arrival at the delivery point, unless authorized by the Engineer.

- Discharge of ready-mixed concrete from the transporting vehicle shall be made while the concrete is still plastic and before stiffening occurs. An elapsed time of 1.5 hours (one hour in non-agitating hauling equipment), or more than 250 revolutions of the drum or blades, after the introduction of the cementitious material to the aggregates, or a temperature of concrete of more than 32°C will be considered as conditions contributing to the quick stiffening of concrete. The Contractor shall take whatever action is necessary to eliminate quick stiffening, except that the addition of water will not be permitted.

- The required mixing time in stationary mixers shall be not less than 50 seconds or more than 5 minutes.

- The minimum required revolutions at mixing speed for transit-mixed concrete shall be not less than that recommended by the mixer manufacturer, and shall be increased, if necessary, to produce thoroughly and uniformly mixed concrete.



- Each load of ready-mixed concrete shall be accompanied by a weight certificate which shall be delivered to the Engineer at the discharge location of the concrete, unless otherwise directed by the Engineer. The weight certificate shall be clearly marked with the date and time of day when the load left the batching plant and, if hauled in truck mixers or agitators, the time the mixing cycle started.

- A Certificate of Compliance conforming to the provisions in Section 6-1.07, "Certificates of Compliance," shall be furnished to the Engineer, prior to placing minor concrete from a source not previously used on the contract, stating that minor concrete to be furnished meets contract requirements, including minimum cementitious material content specified.

The third and fourth paragraphs in Section 90-11.02, "Payment," of the Standard Specifications are amended to read:

- Should the Engineer order the Contractor to incorporate admixtures into the concrete when their use is not required by these specifications or the special provisions, furnishing the admixtures and adding them to the concrete will be paid for as extra work as provided in Section 4-1.03D.

- Should the Contractor use admixtures in conformance with the provisions in Section 90-4.05, "Optional Use of Chemical Admixtures," or Section 90-4.07, "Optional Use of Air-entraining Admixtures," or should the Contractor request and obtain permission to use other admixtures for the Contractor's benefit, the Contractor shall furnish those admixtures and incorporate them in the concrete at the Contractor's expense and no additional compensation will be allowed therefor.

## **SECTION 9. (BLANK)**

## **SECTION 10. CONSTRUCTION DETAILS**

### **SECTION 10-1. GENERAL**

#### **10-1.01 ORDER OF WORK**

Order of work shall conform to the provisions in Section 5-1.05, "Order of Work," of the Standard Specifications and these special provisions.

First order of work shall consist of testing all existing communication equipment including fiber optic cable, closed circuit television systems, ramp metering systems, communications hub equipment, etc.

#### **10-1.02 WATER POLLUTION CONTROL**

Water pollution control work shall conform to the provisions in Section 7-1.01G, "Water Pollution," of the Standard Specifications and these special provisions.

Water pollution control work shall conform to the requirements in the Construction Contractor's Guide and Specifications of the Caltrans Storm Water Quality Handbooks, dated April 1997, and addenda thereto issued up to and including the date of advertisement of the project, hereafter referred to as the "Handbook." Copies of the Handbook may be obtained from the Department of Transportation, Material Operations Branch, Publication Distribution Unit, 1900 Royal Oaks Drive, Sacramento, California 95815, Telephone: (916) 445-3520.

Copies of the Handbook are also available for review at Department of Transportation 464 W. Fourth St. San Bernardino, CA 92401 (909) 383-4561.

The Contractor shall know and fully comply with the applicable provisions of the Handbook and Federal, State, and local regulations that govern the Contractor's operations and storm water discharges from both the project site and areas of disturbance outside the project limits during construction.

Unless arrangements for disturbance of areas outside the project limits are made by the Department and made part of the contract, it is expressly agreed that the Department assumes no responsibility whatsoever to the Contractor or property owner with respect to any arrangements made between the Contractor and property owner to allow disturbance of areas outside the project limits.

The Contractor shall be responsible for the costs and for liabilities imposed by law as a result of the Contractor's failure to comply with the requirements set forth in this section "Water Pollution Control" including, but not limited to, compliance with the applicable provisions of the Handbook and Federal, State, and local regulations. For the purposes of this paragraph, costs and liabilities include, but are not limited to, fines, penalties, and damages whether assessed against the State or the Contractor, including those levied under the Federal Clean Water Act and the State Porter Cologne Water Quality Act.

In addition to the remedies authorized by law, an amount of the money due the Contractor under the contract, as determined by the Department, may be retained by the State of California until disposition has been made of the costs and liabilities.

The retention of money due the Contractor shall be subject to the following:

- A. The Department will give the Contractor 30 days notice of the Department's intention to retain funds from partial payments which may become due to the Contractor prior to acceptance of the contract. Retention of funds from payments made after acceptance of the contract may be made without prior notice to the Contractor.
- B. No retention of additional amounts out of partial payments will be made if the amount to be retained does not exceed the amount being withheld from partial payments pursuant to Section 9-1.06, "Partial Payments," of the Standard Specifications.
- C. If the Department has retained funds and it is subsequently determined that the State is not subject to the costs and liabilities in connection with the matter for which the retention was made, the Department shall be liable for interest on the amount retained at the legal rate of interest for the period of the retention.

Conformance with the provisions in this section "Water Pollution Control" shall not relieve the Contractor from the Contractor's responsibilities as provided in Section 7, "Legal Relations and Responsibilities," of the Standard Specifications.

#### **WATER POLLUTION CONTROL PROGRAM PREPARATION, APPROVAL AND UPDATES**

As part of the water pollution control work, a Water Pollution Control Program, hereafter referred to as the "WPCP," is required for this contract. The WPCP shall conform to the provisions in Section 7-1.01G, "Water Pollution," of the Standard Specifications, the requirements in the Handbook, and these special provisions.

No work having potential to cause water pollution, as determined by the Engineer, shall be performed until the WPCP has been approved by the Engineer.

Within 30 days after the approval of the contract, the Contractor shall submit 3 copies of the WPCP to the Engineer. The Engineer will have 7 days to review the WPCP. If revisions are required, as determined by the Engineer, the Contractor shall revise and resubmit the WPCP within 7 days of receipt of the Engineer's comments. The Engineer will have 7 days to review the revisions. Upon the Engineer's approval of the WPCP, 3 additional copies of the WPCP incorporating the required changes shall be submitted to the Engineer. Minor changes or clarifications to the initial submittal may be made and attached as amendments to the WPCP. In order to allow construction activities to proceed, the Engineer may conditionally approve the WPCP while minor revisions or amendments are being completed.

The WPCP shall identify pollution sources that may adversely affect the quality of storm water discharges associated with the project and shall identify water pollution control measures, hereafter referred to as control measures, to be constructed, implemented, and maintained in order to reduce to the extent feasible pollutants in storm water discharges from the construction site during construction under this contract.

The WPCP shall incorporate control measures in the following categories:

- A. Soil stabilization practices;
- B. Sediment control practices;
- C. Sediment tracking control practices;
- D. Wind erosion control practices; and
- E. Nonstorm water management and waste management and disposal control practices.

Specific objectives and minimum requirements for each category of control measures are contained in the Handbook.

The Contractor shall consider the objectives and minimum requirements presented in the Handbook for each of the above categories. When minimum requirements are listed for any category, the Contractor shall incorporate into the WPCP and implement on the project, one or more of the listed minimum controls required in order to meet the pollution control objectives for the category. In addition, the Contractor shall consider other control measures presented in the Handbook and shall incorporate into the WPCP and implement on the project the control measures necessary to meet the objectives of the WPCP. The Contractor shall document the selection process in conformance with the procedure specified in the Handbook.

The WPCP shall include, but not be limited to, the following items as described in the Handbook:

- A. Project description and Contractor's certification;
- B. Project information;
- C. Pollution sources, control measures, and water pollution control drawings; and
- D. Amendments, if any.

The Contractor shall amend the WPCP, graphically and in narrative form, whenever there is a change in construction activities or operations which may affect the discharge of significant quantities of pollutants to surface waters, ground waters, municipal storm drain systems or when deemed necessary by the Engineer. The WPCP shall be amended if the WPCP has not achieved the objective of reducing pollutants in storm water discharges. Amendments shall show additional control measures or revised operations, including those in areas not shown in the initially approved WPCP, which are required on the

project to control water pollution effectively. Amendments to the WPCP shall be submitted for review and approval by the Engineer in the same manner specified for the initially approved WPCP. Amendments shall be dated and attached to the on-site WPCP document.

The Contractor shall keep a copy of the WPCP, together with updates, revisions and amendments at the project site.

### **WPCP IMPLEMENTATION**

Upon approval of the WPCP, the Contractor shall be responsible throughout the duration of the project for installing, constructing, inspecting, and maintaining the control measures included in the WPCP and any amendments thereto and for removing and disposing of temporary control measures. Unless otherwise directed by the Engineer or specified in these special provisions, the Contractor's responsibility for WPCP implementation shall continue throughout any temporary suspension of work ordered in conformance with the provisions in Section 8-1.05, "Temporary Suspension of Work," of the Standard Specifications. Requirements for installation, construction, inspection, maintenance, removal, and disposal of control measures are specified in the Handbook and these special provisions.

Soil stabilization practices and sediment control measures, including minimum requirements, shall be provided throughout the winter season, defined as between November 1 and March 15.

Implementation of soil stabilization practices and sediment control measures for soil-disturbed areas on the project site shall be completed, except as provided for below, not later than 20 days prior to the beginning of the winter season or upon start of applicable construction activities for projects which begin either during or within 20 days of the winter season.

Throughout the winter season, the active, soil-disturbed area of the project site shall be not more than 1.9 hectares. The Engineer may approve, on a case-by-case basis, expansions of the active, soil-disturbed area limit. The Contractor shall demonstrate the ability and preparedness to fully deploy soil stabilization practices and sediment control measures to protect soil-disturbed areas on the project site before the onset of precipitation. A quantity of soil stabilization and sediment control materials shall be maintained on site equal to 100 percent of that sufficient to protect unprotected, soil-disturbed areas on the project site. A detailed plan for the mobilization of sufficient labor and equipment shall be maintained to fully deploy control measures required to protect unprotected, soil-disturbed areas on the project site prior to the onset of precipitation. A current inventory of control measure materials and the detailed mobilization plan shall be included as part of the WPCP.

Throughout the winter season, soil-disturbed areas on the project site shall be considered to be nonactive whenever soil disturbing activities are expected to be discontinued for a period of 20 or more days and the areas are fully protected. Areas that will become nonactive either during the winter season or within 20 days thereof shall be fully protected with soil stabilization practices and sediment control measures within 10 days of the discontinuance of soil disturbing activities or prior to the onset of precipitation, whichever is first to occur.

Throughout the winter season, active soil-disturbed areas of the project site shall be fully protected at the end of each day with soil stabilization practices and sediment control measures unless fair weather is predicted through the following work day. The weather forecast shall be monitored by the Contractor on a daily basis. The National Weather Service forecast shall be used. An alternative weather forecast proposed by the Contractor may be used if approved by the Engineer. If precipitation is predicted prior to the end of the following work day, construction scheduling shall be modified, as required, and functioning control measures shall be deployed prior to the onset of the precipitation.

The Contractor shall implement, year-round and throughout the duration of the project, control measures included in the WPCP for sediment tracking, wind erosion, nonstorm water management, and waste management and disposal.

The Engineer may order the suspension of construction operations which create water pollution if the Contractor fails to conform to the provisions in this section "Water Pollution Control" as determined by the Engineer.

### **MAINTENANCE**

To ensure the proper implementation and functioning of control measures, the Contractor shall regularly inspect and maintain the construction site for the control measures identified in the WPCP. The Contractor shall identify corrective actions and time needed to address any deficient measures or reinitiate any measures that have been discontinued.

The construction site inspection checklist provided in the Handbook shall be used to ensure that the necessary measures are being properly implemented, and to ensure that the control measures are functioning adequately. One copy of each site inspection record shall be submitted to the Engineer.

During the winter season, inspections of the construction site shall be conducted by the Contractor to identify deficient measures, as follows:

- A. Prior to a forecast storm;
- B. After all precipitation which causes runoff capable of carrying sediment from the construction site;
- C. At 24-hour intervals during extended precipitation events; and
- D. Routinely, at a minimum of once every 2 weeks.

If the Contractor or the Engineer identifies a deficiency in the deployment or functioning of an identified control measure, the deficiency shall be corrected immediately. The deficiency may be corrected at a later date and time if requested by the Contractor and approved by the Engineer in writing, but not later than the onset of subsequent precipitation events. The correction of deficiencies shall be at no additional cost to the State.

#### **PAYMENT**

Full compensation for conforming to the provisions in this section shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefor.

Those control measures which are shown on the plans and for which there is a contract item of work will be measured and paid for as that contract item of work.

The Engineer will retain an amount equal to 25 percent of the estimated value of the contract work performed during estimate periods in which the Contractor fails to conform to the provisions in this section "Water Pollution Control" as determined by the Engineer.

Retentions for failure to conform to the provisions in this section "Water Pollution Control" shall be in addition to the other retentions provided for in the contract. The amounts retained for failure of the Contractor to conform to the provisions in this section will be released for payment on the next monthly estimate for partial payment following the date that a WPCP has been implemented and maintained and water pollution is adequately controlled, as determined by the Engineer.

#### **10-1.03 PRESERVATION OF PROPERTY**

Attention is directed to Section 7-1.11, "Preservation of Property," of the Standard Specifications and these special provisions.

Existing trees, shrubs and other plants, that are not to be removed as shown on the plans or specified in these special provisions, and are injured or damaged by reason of the Contractor's operations, shall be replaced by the Contractor. The minimum size of tree replacement shall be 600 mm box and the minimum size of shrub replacement shall be No. 15 container. Replacement ground cover plants shall be from flats and shall be planted 300 mm on center. Replacement of Carpobrotus ground cover plants shall be from cuttings and shall be planted 300 mm on center. Replacement planting shall conform to the requirements in Section 20-4.07, "Replacement," of the Standard Specifications. The Contractor shall water replacement plants in conformance with the provisions in Section 20-4.06, "Watering," of the Standard Specifications.

Damaged or injured plants shall be removed and disposed of outside the highway right of way in conformance with the provisions in Section 7-1.13 of the Standard Specifications. At the option of the Contractor, removed trees and shrubs may be reduced to chips. The chipped material shall be spread within the highway right of way at locations designated by the Engineer.

Replacement planting of injured or damaged trees, shrubs and other plants shall be completed not less than 20 working days prior to acceptance of the contract. Replacement plants shall be watered as necessary to maintain the plants in a healthy condition.

#### **10-1.04 OBSTRUCTIONS**

Attention is directed to Section 8-1.10, "Utility and Non-Highway Facilities," and Section 15, "Existing Highway Facilities," of the Standard Specifications and these special provisions.

The Contractor shall notify the Engineer and the appropriate regional notification center for operators of subsurface installations at least 2 working days, but not more than 14 calendar days, prior to performing any excavation or other work close to any underground pipeline, conduit, duct, wire or other structure. Regional notification centers include, but are not limited to, the following:

Notification Center	Telephone Number
Underground Service Alert-Northern California (USA)	1-800-642-2444 1-800-227-2600
Underground Service Alert-Southern California (USA)	1-800-422-4133 1-800-227-2600

#### **10-1.05 CONSTRUCTION AREA SIGNS**

Construction area signs shall be furnished, installed, maintained, and removed when no longer required in conformance with the provisions in Section 12, "Construction Area Traffic Control Devices," of the Standard Specifications and these special provisions.

Attention is directed to the provisions in "Approved Traffic Products" of these special provisions. Type II retroreflective sheeting shall not be used on construction area sign panels.

The Contractor shall notify the appropriate regional notification center for operators of subsurface installations at least 2 working days, but not more than 14 calendar days, prior to commencing excavation for construction area sign posts. The regional notification centers include, but are not limited to, the following:

Notification Center	Telephone Number
Underground Service Alert-Northern California (USA)	1-800-642-2444 1-800-227-2600
Underground Service Alert-Southern California (USA)	1-800-422-4133 1-800-227-2600

Excavations required to install construction area signs shall be performed by hand methods without the use of power equipment, except that power equipment may be used if it is determined there are no utility facilities in the area of the proposed post holes.

Sign substrates for stationary mounted construction area signs may be fabricated from fiberglass reinforced plastic as specified under "Approved Traffic Products" of these special provisions.

#### **10-1.06 MAINTAINING TRAFFIC**

Attention is directed to Sections 7-1.08, "Public Convenience," 7-1.09, "Public Safety," and 12, "Construction Area Traffic Control Devices," of the Standard Specifications and to the provisions in "Public Safety" of these special provisions and these special provisions. Nothing in these special provisions shall be construed as relieving the Contractor from the responsibilities specified in Section 7-1.09.

Lane closures shall conform to the provisions in section "Traffic Control System for Lane Closure" of these special provisions.

The Contractor shall notify local authorities of the Contractor's intent to begin work at least 5 days before work is begun. The Contractor shall cooperate with local authorities relative to handling traffic through the area and shall make arrangements relative to keeping the working area clear of parked vehicles.

Whenever vehicles or equipment are parked on the shoulder within 1.8 m of a traffic lane, the shoulder area shall be closed.

Lanes shall be closed only during the hours shown on the charts included in this section "Maintaining Traffic." Except work required under Sections 7-1.08 and 7-1.09, work that interferes with public traffic shall be performed only during the hours shown for lane closures.

Designated legal holidays are: January 1st, the third Monday in February, the last Monday in May, July 4th, the first Monday in September, November 11th, Thanksgiving Day, and December 25th. When a designated legal holiday falls on a Sunday, the following Monday shall be a designated legal holiday. When November 11th falls on a Saturday, the preceding Friday shall be a designated legal holiday.

Minor deviations from the requirements of this section concerning hours of work which do not significantly change the cost of the work may be permitted upon the written request of the Contractor, if in the opinion of the Engineer, public traffic will be better served and the work expedited. These deviations shall not be adopted by the Contractor until the Engineer has approved the deviations in writing. All other modifications will be made by contract change order.

Chart No. 1 Multilane Lane Requirements EA 449911																									
Location: 08-Riv-91-K.P. 11.9/18.4, EASTBOUND																									
FROM HOUR TO HOUR	a.m.												p.m.												
	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Mondays through Thursdays	2	2	2	2	2	2	2	1														1	1	2	2
Fridays	2	2	2	2	2	2	2	1																	
Saturdays																									
Sundays																									
Day before designated legal holiday	2	2	2	2	2	2	2	1																	
Designated legal holidays																									
Day after holidays																						1	1	2	2
1	1-Lane Closed: (A) HOV closed only, or (B) Auxiliary Lane closed only, or (C) #3 Lane closed only (when no auxiliary lane) or (D) #3 & Auxiliary Lanes closed only. (See Remark #2 below)																								
2	2-Lane Closed, max.: (A) HOV & #1 Lane closed only, or (B) #2 & #3 (when no auxiliary lane), or (C) #2, #3 & auxiliary lane (if existing) closed only. (See Remark #2 below)																								
	No lane closure allowed																								
REMARKS: 1. Chart shows # of lanes closed. 2. The auxiliary lane is not a through-traffic lane. The auxiliary lane shall be closed when the adjacent #3 lane is closed.																									

Chart No. 2 Multilane Lane Requirements EA 449911																									
Location: 08-Riv-91-K.P. 11.9/18.4, WESTBOUND																									
FROM HOUR TO HOUR	a.m.												p.m.												
	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Mondays through Thursdays	2	2	2	2	1																1	2	2	2	2
Fridays	2	2	2	2	1																				
Saturdays																									
Sundays																									
Day before designated legal holiday																									
Designated legal holidays	2	2	2	2	1																				
Day after Holiday																					1	2	2	2	2
1	1-Lane Closed: (A) HOV closed only, or (B) Auxiliary Lane closed only, or (C) #3 Lane closed only (when no auxiliary lane) or (D) #3 & Auxiliary Lanes closed only. (See Remark #2 below)																								
2	2-Lane Closed, max.: (A) HOV & #1 Lane closed only, or (B) #2 & #3 (when no auxiliary lane), or (C) #2, #3 & auxiliary lane (if existing) closed only. (See Remark #2 below)																								
	No lane closure allowed																								
REMARKS: 1. Chart shows # of lanes closed. 2. The auxiliary lane is not a through-traffic lane. The auxiliary lane shall be closed when the adjacent #3 lane is closed.																									

### 10-1.07 CLOSURE REQUIREMENTS AND CONDITIONS

Lane closures shall conform to the provisions in "Maintaining Traffic" of these special provisions and these special provisions.

The term closure, as used herein, is defined as the closure of a traffic lane or lanes, including ramp or connector lanes, within a single traffic control system.

#### CLOSURE SCHEDULE

By Noon Monday, the Contractor shall submit a written schedule of planned closures for the following week period, defined as Friday Noon through the following Friday Noon.

The Closure Schedule shall show the locations and times when the proposed closures are to be in effect. The Contractor shall use the Closure Schedule request forms furnished by the Engineer. Closure Schedules submitted to the Engineer with incomplete, unintelligible or inaccurate information will be returned for correction and resubmittal. The Contractor will be notified of disapproved closures or closures that require coordination with other parties as a condition of approval.

Amendments to the Closure Schedule, including adding additional closures, shall be submitted to the Engineer, in writing, at least 3 working days in advance of a planned closure. Approval of amendments to the Closure Schedule will be at the discretion of the Engineer.

The Contractor shall confirm, in writing, all scheduled closures by no later than 8:00 a.m. 3 working days prior to the date on which the closure is to be made. Approval or denial of scheduled closures will be made no later than 4:00 p.m. 2 working days prior to the date on which the closure is to be made. Closures not confirmed or approved will not be allowed.

Confirmed closures that are cancelled due to unsuitable weather may be rescheduled at the discretion of the Engineer for the following working day.

#### CONTINGENCY PLAN

The Contractor shall prepare a contingency plan for reopening closures to public traffic. The Contractor shall submit the contingency plan for a given operation to the Engineer within one working day of the Engineer's request.

## **LATE REOPENING OF CLOSURES**

If a closure is not reopened to public traffic by the specified time, work shall be suspended in conformance with the provisions in Section 8-1.05, "Temporary Suspension of Work," of the Standard Specifications. The Contractor shall not make any further closures until the Engineer has accepted a work plan, submitted by the Contractor, that will insure that future closures will be reopened to public traffic at the specified time. The Engineer will have 2 working days to accept or reject the Contractor's proposed work plan. The Contractor will not be entitled to any compensation for the suspension of work resulting from the late reopening of closures.

### **10-1.08 TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE**

A traffic control system shall consist of closing traffic lanes in conformance with the details shown on the plans, the provisions in Section 12, "Construction Area Traffic Control Devices," of the Standard Specifications, the provisions under "Maintaining Traffic" and "Construction Area Signs" of these special provisions, and these special provisions.

The provisions in this section will not relieve the Contractor from the responsibility to provide additional devices or take measures as may be necessary to comply with the provisions in Section 7-1.09, "Public Safety," of the Standard Specifications.

Each vehicle used to place, maintain and remove components of a traffic control system on multilane highways shall be equipped with a Type II flashing arrow sign which shall be in operation when the vehicle is being used for placing, maintaining or removing components. Vehicles equipped with Type II flashing arrow sign not involved in placing, maintaining or removing components when operated within a stationary lane closure shall only display the caution display mode. The sign shall be controllable by the operator of the vehicle while the vehicle is in motion. The flashing arrow sign shown on the plans shall not be used on vehicles which are being used to place, maintain and remove components of a traffic control system and shall be in place before a lane closure requiring its use is completed.

If components in the traffic control system are displaced or cease to operate or function as specified, from any cause, during the progress of the work, the Contractor shall immediately repair the components to the original condition or replace the components and shall restore the components to the original location.

When lane closures are made for work periods only, at the end of each work period, components of the traffic control system, except portable delineators placed along open trenches or excavation adjacent to the traveled way, shall be removed from the traveled way and shoulder. If the Contractor so elects, the components may be stored at selected central locations designated by the Engineer within the limits of the highway right of way.

The contract lump sum price paid for traffic control system shall include full compensation for furnishing all labor, materials (including signs), tools, equipment, and incidentals, and for doing all the work involved in placing, removing, storing, maintaining, moving to new locations, replacing, and disposing of the components of the traffic control system shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The adjustment provisions in Section 4-1.03, "Changes," of the Standard Specifications shall not apply to the item of traffic control system. Adjustments in compensation for traffic control system will be made only for increased or decreased traffic control system required by changes ordered by the Engineer and will be made on the basis of the cost of the increased or decreased traffic control necessary. The adjustment will be made on a force account basis as provided in Section 9-1.03, "Force Account Payment," of the Standard Specifications for increased work and estimated on the same basis in the case of decreased work.

Traffic control system required by work which is classed as extra work, as provided in Section 4-1.03D of the Standard Specifications, will be paid for as a part of the extra work.

### **10-1.09 PORTABLE CHANGEABLE MESSAGE SIGN**

Portable changeable message signs shall be furnished, placed, operated, and maintained at those locations shown on the plans or where designated by the Engineer in conformance with the provisions in Section 12, "Construction Area Traffic Control Devices," of the Standard Specifications and these special provisions.

Attention is directed to "Maintaining Traffic" of these special provisions regarding the use of the portable changeable message signs.

### **10-1.10 TEMPORARY CRASH CUSHION MODULE**

This work shall consist of furnishing, installing, and maintaining sand filled temporary crash cushion modules in groupings or arrays at each location shown on the plans, as specified in these special provisions or where designated by the Engineer. The grouping or array of sand filled modules shall form a complete sand filled temporary crash cushion in conformance with these special provisions.

Attention is directed to "Public Safety", and "Order of Work" of these special provisions.



## **GENERAL**

Whenever the work or the Contractor's operations establishes a fixed obstacle, the exposed fixed obstacle shall be protected with a sand filled temporary crash cushion. The sand filled temporary crash cushion shall be in place prior to opening the lanes adjacent to the fixed obstacle to public traffic.

Sand filled temporary crash cushions shall be maintained in place at each location, including times when work is not actively in progress. Sand filled temporary crash cushions may be removed during a work period for access to the work provided that the exposed fixed obstacle is 4.6 m or more from a lane carrying public traffic and the temporary crash cushion is reset to protect the obstacle prior to the end of the work period in which the fixed obstacle was exposed. When no longer required, as determined by the Engineer, sand filled temporary crash cushions shall be removed from the site of the work.

## **MATERIALS**

At the Contractor's option, the modules for use in sand filled temporary crash cushions shall be either Energite III Inertial Modules, Fitch Inertial Modules or Traffix Sand Barrels manufactured after March 31, 1997, or equal:

- A. Energite III Inertial Modules, manufactured by Energy Absorption Systems, Inc., One East Wacker Drive, Chicago, IL 60601-2076, Telephone 1-312-467-6750, FAX 1-800-770-6755.
  - 1. Distributor (Northern): Traffic Control Service, Inc., 8585 Thys Court, Sacramento, CA 95828, Telephone 1-800-884-8274, FAX 1-916-387-9734
  - 2. Distributor (Southern): Traffic Control Service, Inc., 1881 Betmor Lane, Anaheim, CA 92805, Telephone 1-800-222-8274, FAX 1-714-937-1070.
- B. Fitch Inertial Modules, manufactured by Roadway Safety Service, Inc., 1050 North Rand Road, Wauconda, IL 60084, Telephone 1-800-426-0839, FAX 1-847-487-9820.
  - 1.. Distributor (Northern): Traffic Control Service, Inc., 8585 Thys Court, Sacramento, CA 95828, Telephone 1-800-884-8274, FAX 1-916-387-9734
  - 2. Distributor (Southern): Traffic Control Service, Inc., 1881 Betmor Lane, Anaheim, CA 92805, Telephone 1-800-222-8274, FAX 1-714-937-1070.
- C. Traffix Sand Barrels, manufactured by Traffix Devices, Inc., 220 Calle Pintoresco, San Clemente, CA 92672, Telephone 1-949-361-5663, FAX 1-949-361-9205.
  - 1. Russ Enterprises, Inc., 1533 Berger Drive, San Jose, CA 95112, Telephone 1-408-287-4303, FAX 1-408-287-1929.
  - 2. Statewide Safety, P.O. Box 1440, Pismo Beach, CA 93448, Telephone 1-800-559-7080, FAX 1-805-929-5786.

Modules contained in each temporary crash cushion shall be of the same type at each location. The color of the modules shall be the standard yellow color, as furnished by the vendor, with black lids. The modules shall exhibit good workmanship free from structural flaws and objectionable surface defects. The modules need not be new. Good used undamaged modules conforming to color and quality of the types specified herein may be utilized. If used Fitch modules requiring a seal are furnished, the top edge of the seal shall be securely fastened to the wall of the module by a continuous strip of heavy duty tape.

Modules shall be filled with sand in conformance with the manufacturer's directions, and to the sand capacity in kilograms for each module shown on the plans. Sand for filling the modules shall be clean washed concrete sand of commercial quality. At the time of placing in the modules, the sand shall contain not more than 7 percent water as determined by California Test 226.

Modules damaged due to the Contractor's operations shall be repaired immediately by the Contractor at the Contractor's expense. Modules damaged beyond repair, as determined by the Engineer, due to the Contractor's operations shall be removed and replaced by the Contractor at the Contractor's expense.

## **INSTALLATION**

Temporary crash cushion modules shall be placed on movable pallets or frames conforming to the dimensions shown on the plans. The pallets or frames shall provide a full bearing base beneath the modules. The modules and supporting pallets or frames shall not be moved by sliding or skidding along the pavement or bridge deck.

A Type R or P marker panel shall be attached to the front of the crash cushion as shown on the plans, when the closest point of the crash cushion array is within 3.6 m of the traveled way. The marker panel, when required, shall be firmly fastened to the crash cushion with commercial quality hardware or by other methods determined by the Engineer.

At the completion of the project, temporary crash cushion modules, sand filling, pallets or frames, and marker panels shall become the property of the Contractor and shall be removed from the site of the work. Temporary crash cushion modules shall not be installed in the permanent work.

#### **MEASUREMENT AND PAYMENT**

Temporary crash cushion modules placed in conformance with the provisions in "Public Safety" of these special provisions will not be measured nor paid for.

#### **10-1.11 EXISTING HIGHWAY FACILITIES**

The work performed in connection with various existing highway facilities shall conform to the provisions in Section 15, "Existing Highway Facilities," of the Standard Specifications and these special provisions.

##### **10-1.11A EXISTING FIBER OPTIC FACILITIES**

Existing fiber optic facilities that are shown on the plans to remain, or to be maintained or relocated as part of this contract, shall be protected from damage. If the Contractor's operations damage such existing fiber optic facilities, the Contractor shall, at his expense, repair or replace the damaged facilities as follows:

Repair or replacement of damaged facilities shall be completed within 3 working days of the damage.

Replaced fiber optic facilities shall be new, and of equal or better quality than the damaged facility. Such replacement fiber optic facilities shall be compatible with the fiber optic systems to remain.

After repair or replacement of such facilities is complete, the Contractor shall demonstrate to the Engineer that the repaired or replaced facilities operate properly.

Should the Contractor fail to perform the required repairs or replacement work, the repairs will be made by State forces and the cost of performing such repairs or replacement work will be deducted from any money due or become due to the Contractor.

At locations where potholing may be required to locate fiber optic facilities as determined by the Engineer, the costs of potholing will be paid for as extra work as provided in Section 4-1.03D of the Standard Specifications.

### **SECTION 10-2 HIGHWAY PLANTING AND IRRIGATION SYSTEMS**

#### **10-2.01 GENERAL**

The work performed in connection with highway planting and irrigation systems shall conform to the provisions in Section 20, "Erosion Control and Highway Planting," of the Standard Specifications and these special provisions.

#### **10-2.02 EXISTING HIGHWAY PLANTING**

In addition to the provisions in Section 20 of the Standard Specifications, work performed in connection with existing highway planting shall be in conformance with the provisions in Section 15, "Existing Highway Facilities," of the Standard Specifications and these special provisions.

Replacement planting shall conform to the requirements specified under "Preservation of Property" of these special provisions.

**MAINTAIN EXISTING PLANTS** Existing plants shall be maintained as directed by the Engineer. Maintaining existing plants will be paid for as extra work as provided in Section 4-1.03D of the Standard Specifications.

#### **10-2.03 EXISTING HIGHWAY IRRIGATION FACILITIES**

The work performed in connection with the various existing highway irrigation system facilities shall conform to the provisions in Section 15, "Existing Highway Facilities," of the Standard Specifications and these special provisions.

Water shall be maintained in conformance with the provisions in Section 20-5.025, "Maintain Existing Water Supply," of the Standard Specifications.

#### **CHECK AND TEST EXISTING IRRIGATION FACILITIES**

Existing irrigation facilities that are to remain or to be relocated, and that are within those areas where clearing and grubbing or earthwork operations are to be performed, shall be checked for missing or damaged components and proper operation prior to performing clearing and grubbing or earthwork operations. Existing irrigation facilities outside of work areas that are affected by the construction work shall also be checked for proper operation.

Repairs to the existing irrigation facilities ordered by the Engineer after checking and testing the facilities, and further repairs required thereafter as ordered by the Engineer, except as otherwise provided for under "Maintain Existing Irrigation Facilities" of these special provisions, will be paid for as extra work as provided in Section 4-1.03D of the Standard Specifications.

#### **MAINTAIN EXISTING IRRIGATION FACILITIES**

Existing irrigation facilities shall be maintained throughout the life of the contract. Prior to the start of maintaining existing irrigation facilities work, the facilities shall be checked for proper operation, and repaired in conformance with the provisions in "Check and Test Existing Irrigation Facilities" of these special provisions.

After the existing facilities have been checked and repaired, the Contractor shall be responsible for the routine maintenance of existing irrigation systems. The work shall include, but not limited to, checking irrigation systems for proper operation and adjusting, repairing or replacing valves, valve boxes, sprinklers, risers, swing joints, wye strainers, valve assembly units, and filter assembly units.

The Contractor will not be responsible for maintaining existing water meters, underground pipe supply lines, control and neutral conductors, and electrical conduits. Except as otherwise specified in section "Existing Highway Irrigation Facilities" of these special provisions, repair work to these facilities ordered by the Engineer will be paid for as extra work as provided in Section 4-1.03D of the Standard Specifications.

Existing automatic irrigation systems shall be operated automatically during the life of the contract, except manual operation will be allowed for the work during plant replacement, and the repair of irrigation facilities.

Irrigation controllers shall be programmed by the Contractor for seasonal water requirements. During winter seasons irrigation systems shall be operated automatically a minimum of 2 minutes every 2 weeks.

Irrigation systems and facilities shall be checked for proper operation at least once every 30 days. When required, as determined by the Engineer, adjusting, repairing or replacing irrigation facilities shall be completed within 5 working days after checking the irrigation systems. Except as provided in these special provisions, repair and replacement of irrigation facilities shall conform to the provisions in "Existing Highway Irrigation Facilities" of these special provisions.

### **SECTION 10-3. SIGNALS, LIGHTING AND ELECTRICAL SYSTEMS**

#### **10-3.01 DESCRIPTION**

Vehicle detection stations, modify ramp metering systems, modify transportation management center, modify communication hub assembly, traffic operation system cabinet assembly, and closed circuit television system shall conform to the provisions in Section 86, "Signals, Lighting and Electrical Systems," of the Standard Specifications and these special provisions.

Vehicle detection stations (installing new VDS's and connecting them to exist fiber optic backbone) work shall be performed at the following locations:

- Location 1 at K.P. 12.9 (EB West of Promenade Ave OC)
- Location 2 at K.P. 14.1 (EB West of McKinley St. UC )
- Location 3 at K.P. 15.4 (EB East of McKinley St. UC)
- D. Location 4 at K.P. 16.4 (WB East of Buchanan St OC)

Modify ramp metering systems (connecting existing RMS's to existing fiber optic backbone, and for locations 1, 4 and 6 install VDS in exist RMS cabinet as shown on the plans.) work shall be performed at the following locations:

- Location 1 at K.P. 14.5 (WB at McKinley St. UC )
- Location 2 at K.P. 14.8 (EB at McKinley St. UC)
- Location 3 at K.P. 15.1 (EB at McKinley St. UC)
- Location 4 at K.P. 17.1 (WB at Pierce St.)
- Location 5 at K.P. 17.5 (WB at Magnolia Ave)
- Location 6 at K.P. 18.1 (EB at Magnolia Ave)

Closed circuit television system work shall be performed at the following locations:

- A. At K.P. 17.5 (EB West of Magnolia Ave)

Traffic operation system cabinet assembly work shall be performed at the following locations:

- A. At K.P. 18.1 (EB At Magnolia Ave. Entrance Ramp)

Modify communication hub assembly work shall be performed at the following locations:

- A. At NE quadrant of 91/15 interchange (Hub A)

Modify transportation management center equipment work shall be performed at the following locations:

- A. At District Office 464 W. 4<sup>th</sup> St. San Bernardino Room # B-39

### **10-3.02 COST BREAK-DOWN**

Cost break-downs shall conform to the provisions in Section 86-1.03, "Cost Break-Down," of the Standard Specifications and these special provisions.

The Engineer shall be furnished a cost break-down for each contract lump sum item of work.

The cost break-down shall be submitted to the Engineer for approval within 15 days after the contract has been approved. The cost break-down shall be approved, in writing, by the Engineer before any partial payment for the items of electrical work will be made.

The cost breakdown shall include the following items in addition to those listed in the Standard Specifications:

- A. Closed Circuit Television, Lens and Environmental Enclosure
- B. Pan /Tilt Unit
- C. Camera Pole
- D. Type 334-CCTV Cabinet
- E. Interconnect Wiring
- F. Camera Transceiver
- G. Auxiliary Control Unit
- H. Interconnect and Termination Unit
- I. Fiber Optic Pigtails and Jumpers
- J. Video Multiplexer
- K. Video Demultiplexer
- L. Card Cage Assembly
- M. Fiber Optic Bypass Modem / Switch (all types)
- N. RS232 Serial Cables
- O. Asynchronous Fiber Optic Modems
- P. System Testing and Documentation

### **10-3.03 CONDUIT**

All conduits to be installed underground shall be Type 1 unless otherwise specified. Detector termination conduits shall be Type 3 .

The conduit in a foundation and between a foundation and the nearest pull box shall be Type 1.

Conduit sizes shown on the plans and specified in the Standard Specifications and these special provisions are referenced to metallic type conduit. rigid non-metallic rigid non-metallic or reinforced fiberglass conduit is required or allowed, the nominal equivalent industry size shall be used as shown in the following table:

Size Designation for Metallic Type Conduit	Equivalent Size for Rigid Non-metallic Conduit
21	20
27	25
41	40
53	50
63	65
78	75
103	100

After conductors have been installed, the ends of conduits terminating in pull boxes, service equipment enclosures, Type 334-CCTV cabinet and controller cabinets shall be sealed with an approved type of sealing compound. Except as otherwise noted, all conduits containing F/O cables and innerducts shall have their ends sealed with commercial preformed plugs which prevent the passage of gas, dust and water into these conduits and their included innerducts. Sealing plugs shall be installed within each splice vault, pull box, cabinet, or building. Sealing plugs shall be removable and reusable. Plugs sealing innerducts, conductor or cable shall be the split type that permits installation or removal without removing conductors or cables.

Sealing plugs that seal between the fiber optic conduit and innerducts shall seal the conduit and all innerducts simultaneously with one self contained assembly having an adjustable resilient filler of neoprene or silicone rubber clamped between backing ends and compressed with stainless steel hardware.

Sealing plugs that seal the innerducts shall seal each innerduct individually with appropriate sizes and configuration to accommodate either empty ducts or those containing fiber optic cable. To provide suitable sealing between the varying size cables and the plugs, split neoprene or silicone adapting sleeves, used singularly or in multiples, shall be inserted within the body of the plugs.

Sealing plugs used to seal fiber optic conduit and innerducts shall be capable of withstanding a pressure of 34.5 kPa.

A sealing plug that seals an empty conduit or innerduct shall have an eye or other type of capturing device (on the side of the plug that enters the conduit) to attach onto the pull rope, so the pull rope will be easily accessible when the plug is removed.

Full compensation for conduit and innerduct sealing plugs shall be considered as included in the prices paid for the conduit and innerduct they are sealing and no separate payment will be made therefor.

At locations where conduit is required to be installed under pavement and if a delay to vehicles will not exceed 5 minutes, conduit may be installed by the "Trenching in Pavement Method."

#### 10-3.04 INNERDUCT

Innerduct shall be installed wherever fiber optic cable is installed in conduit, except conduit housing Type D fiber optic cable exclusively.

Innerduct consists of an extruded flexible annealed polyethylene tubing that is installed inside electrical conduit, and which in turn the fiber optic cable is installed. Innerduct within a conduit run shall be continuous without splices or joints. Innerduct for this project shall be continuous longitudinally ribbed inside and outside.

Unless otherwise shown on the plans, innerduct for this project shall be nominal 25 mm inside diameter, with wall thickness of  $2300\mu\text{m} \pm 80\mu\text{m}$ , and shall meet the following requirements:

Polyethylene for innerduct shall have a density of  $0.955 \pm 0.005 \text{ gm/cm}^3$  (ASTM Standard D-1505), and shall conform to the applicable portions of ASTM Designations: D 3485, D 3035, D 2239, and D 2447, and the applicable portions of NEMA TC7 and TC2. Tensile yield strength shall be 3300 psi, minimum (ASTM D-638).

Different innerducts within the same conduits shall be different colors and the colors chosen shall be consistent with the required cables throughout the project. One innerduct shall be gray and it shall house Type C fiber optic cable. The innerduct shall be shipped on reels marked with the manufacturer, the contract number, and the size and length of the innerduct. The product on reels shall be covered with aluminized material to protect colors from UV deterioration during shipment and storage.

Immediately prior to installing innerducts, all conduits shall be blown out with compressed air until all foreign material is removed. After cables, conductors and/or innerduct have been installed, the ends of innerducts shall be sealed with an approved type of sealing plugs.

A manufacturer recommended lubricant shall be applied between the innerducts and the conduit during installation to reduce friction.

Installation procedures shall conform to the procedures specified by the innerduct manufacturer. If the innerduct is installed using mechanical assistance, a dynamometer shall be used to record installation tension and a tension limiting device shall be used to prevent exceeding the maximum pulling tension during installation. The tension shall be set to the manufacturer's maximum limit. The maximum pulling tension shall be recorded for each innerduct run. The innerduct shall not be stressed beyond the minimum bending radius allowed by either the innerduct or fiber optic cable manufacturer.

Immediately prior to installing cables, innerduct shall be blown out with compressed air until all foreign material is removed. After cables have been installed, the ends of innerducts shall be sealed with an approved type of rubber conduit plug.

Each innerduct shall be one continuous unit within a conduit run.

#### **10-3.05 PULL BOXES**

Grout shall be placed in the bottom of pull boxes.

#### **10-3.06 CONDUCTORS AND WIRING**

Splices shall be insulated by "Method B" .

##### **SIGNAL INTERCONNECT CABLE.**

Signal Interconnect Cable (SIC) shall be the 6-pair type.

#### **10-3.07 SERVICE**

Continuous welding of exterior seams in service equipment enclosures is not required.

Type III service equipment enclosures shall be the aluminum type.

Circuit breakers shall be mounted on non-energized clips. All circuit breakers shall be mounted vertically with the up position of the handle being the "ON" position.

The Contractor shall pay for all connection fees.

#### **10-3.08 STATE-FURNISHED CONTROLLER ASSEMBLIES**

The Model 170 controller assemblies, including controller unit, completely wired controller cabinet and inductive loop detector sensor units, but without anchor bolts, will be State-furnished as provided under "Materials" of these special provisions.

The Contractor shall construct each controller cabinet foundation as shown on the plans for Model 332 and 334 cabinets (including furnishing and installing anchor bolts), shall install the controller cabinet on the foundation, and shall make field wiring connections to the terminal blocks in the controller cabinet. Model 334 cabinets shall be used for VDS and TOS cabinets.

A listing of field conductor terminations, in each State-furnished controller cabinet, will be furnished free of charge to the Contractor at the site of the work.

State forces will maintain controller assemblies. The Contractor's responsibility for controller assemblies shall be limited to conforming to the provisions in Section 6-1.02, "State-Furnished Materials," of the Standard Specifications.

#### **10-3.09 DETECTORS**

Loop detector sensor units, will be State-furnished in conformance with the provisions in "Materials" of these special provisions.

Loop wire shall be Type 2.

Loop detector lead-in cable shall be Type B.

Slots shall be filled with hot-melt rubberized asphalt sealant.

At the Contractor's option, where a Type A or a Type B loop is designated on the plans, a Type E loop may be substituted.

For Type E detector loops, sides of the slot shall be vertical and the minimum radius of the slot entering and leaving the circular part of the loop shall be 40 mm. Slot width shall be a maximum of 20 mm. Loop wire for circular loops shall be Type 2. Slots of circular loops shall be filled with or hot melt rubberized asphalt sealant.

#### **10-3.10 PAYMENT**

The contract lump sum prices paid for vehicle detection station at the locations shown in the Engineer's estimate shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing the vehicle detection station and connecting to existing fiber optic backbone and any ancillary or

incidental items required to provide full equipment operation at each site, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

## **SECTION 10-4. FIBER OPTIC COMMUNICATION CABLE PLANT**

### **10-4.01 FIBER OPTICS GLOSSARY**

**Breakout.--** The cable "breakout" is produced by (1) removing the jacket just beyond the last tie-wrap point, (2) exposing 1 to 2 m of the cable buffers, aramid strength yarn and central fiberglass strength member, and (3) cutting the aramid yarn, central strength member and the buffer tubes to expose the individual glass fibers for splicing or connection to the appropriate device.

**Connector.--** A mechanical device used to provide a means for attaching to and decoupling from a transmitter, receiver, or another fiber (such as on a patch panel).

**Connectorized.--** The termination point of a fiber after connectors have been affixed.

**Connector Module Housing (CMH).--**A patch panel used to terminate singlemode or multimode fibers with most common connector types. It may include a jumper storage shelf and a hinged door.

**Couplers.--** Couplers are devices which mate two fiber optic connectors to facilitate the transition of optical light signals from one connector into another. They are normally located within FDFs and ITUs mounted in panels. They may also be used unmounted, to join two simplex fiber runs.

**F/O.--** Fiber optic

**FOIP.--** Fiber optic inside plant cable

**FOP.--** Fiber optic outside plant cable

**FOTP.--** Fiber optic test procedure(s) as defined by EIA/TIA standards.

**Interconnect and Termination Unit (ITU)--**A patch panel used to terminate fibers with most common connector types. It may include a jumper storage shelf and a hinge door.

**Jumper.--**A short, typically 1 meter or less, used to join two Connector Module Housing (CMH) couplers or a CMH to active electronic components.

**Light Source.--** Portable fiber optic test equipment that, when coupled with a power meter, is used to perform end-to-end attenuation testing. It contains a stabilized light source operating at the designed wavelength of the system under test.

**Link.--** A passive section of the system, the ends of which are connectorized. A link may include splices and couplers. For example, a video link may be from a F/O transmitter to a video multiplexer (MUX).

**Link Loss Budget.--** A calculation of the overall permissible attenuation from the fiber optic transmitter (source) to the fiber optic receiver (detector).

**Loose Tube Cable.--** Type of cable construction in which fibers are placed in filled buffer tubes to isolate them from outside forces (stress). A flooding compound or material is applied to the interstitial cable core to prevent water migration and penetration. This type of cable is primarily for outdoor applications.

**Mid-Span Access Method.--** A procedure in which fibers from a single buffer tube are accessed and spliced to an adjoining cable without cutting the unused fibers in the buffer tube or disturbing the remaining buffer tubes in the cable.

**Optical Time Domain Reflectometer (OTDR).--**Fiber optic test equipment similar in appearance to an oscilloscope that is used to measure the total amount of power in a fiber optic cable between two points. It provides a visual and printed display of the losses associated with system components such as fiber, splices and connectors.

**Patchcord.--** A term used interchangeably with "jumper".

**Patch Panel.--** A precision drilled metal frame containing couplers used to make two (2) fiber optic connectors.

**Pigtail.--** Relatively short length of fiber optic cable that is connectorized on only one end.

**Power Meter.--** Portable fiber optic test equipment that, when coupled with a light source, is used to perform end-to-end attenuation testing. It contains a detector that is sensitive to light at the designed wavelength of the system under test. It's display indicates the amount of optical power received at the end of the link.

**Riser Cable.--** NEC approved cable installed in a riser (a vertical shaft in a building connecting one floor to another).

**Segment.--** A section of F/O cable that is not connected to any active device and may or may not have splices per the design.

**Splice.--** The permanent joining of two fiber ends using a fusion splicer.

**Splice Closure.--** An environmentally sealed container used to organize and protect splice trays. The container allows splitting or routing of fiber cables from multiple locations. Normally installed in a splice vault.

**Splice Module Housing (SMH).--**A unit that stores splice trays as well as pigtails and short cable lengths. The unit allows splitting or routing of fiber cables to or from multiple locations.

**Splice Tray.--** A container used to organize and protect spliced fibers.

**Splice Vault.--** A container used to organize and protect spliced fibers.

**Tight Buffered, Non-Breakout Cable (Tight Buffer Cable).--**Type of cable construction where each glass fiber is tightly buffered (directly coated) with a protective thermoplastic coating to 900  $\mu\text{m}$  (compared to 250  $\mu\text{m}$  for loose tube fibers).

## **10-4.02 FIBER OPTIC OUTSIDE PLANT CABLE**

### **10-4.02A GENERAL**

Each fiber optic outside plant cable (FOP) for this project shall be all dielectric, gel filled, duct type, with loose buffer tubes and shall conform to these special provisions. Cables with singlemode fibers shall contain 12, or 48 singlemode (SM) dual-window (1310 nm and 1550 nm) fibers.

The optical fibers shall be contained within loose buffer tubes. The loose buffer tubes shall be stranded around an all dielectric central member. Aramid yarn and/or fiberglass shall be used as a primary strength member, and a polyethylene outside jacket shall provide for overall protection.

All fiber optic (F/O) cable on this project shall be from the same manufacturer, who is regularly engaged in the production of this material.

The cable shall be qualified as compliant with Chapter XVII, Title 7, Part 1755-900 of the Code of Federal Regulations, "REA specification for filled fiber optic cables" (which replaced the United States Department of Agriculture Rural Electrification Administration specifications REA-PE-90).

The following is the fiber count for each type of fiber optic cable:

Type C fiber optic cable shall contain 48 singlemode fibers.

Type D fiber optic cable shall contain 12 singlemode fibers.

### **10-4.02B FIBER CHARACTERISTICS**

Each optical fiber shall be glass and consist of a doped silica core surrounded by concentric silica cladding. All fibers in the buffer tube shall be usable fibers, and shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of these specifications. The required fiber grade SM shall reflect the maximum individual fiber attenuation, to guarantee the required performance of each and every fiber in the cable.

The coating shall be a dual layered, UV cured acrylate. The coating shall be mechanically or chemically strippable without damaging the fiber.



The cable shall comply with the optical and mechanical requirements over an operating temperature range of -40°C to +70°C. The cable shall be tested in accordance with EIA-455-3A (FOTP-3), "Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components." The change in attenuation at extreme operational temperatures (-40°C to +70°C) for singlemode fiber shall not be greater than 0.20 dB/km, with 80 percent of the measured values no greater than 0.10 dB/km. The singlemode fiber measurement is made at 1550 nm.

For all fibers the attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable.

Singlemode fibers within the finished cable shall meet the requirements in the following table:

**Fiber Characteristics Table**

<b>Parameters</b>	<b>SM</b>
Type	Step Index
Core diameter	8.3 $\mu\text{m}$ (nominal)
Cladding diameter	125 $\mu\text{m} \pm 1.0 \mu\text{m}$
Core to Cladding Offset	<0.8 $\mu\text{m}$
Coating Diameter	250 $\mu\text{m} \pm 15 \mu\text{m}$
Cladding Non-circularity defined as: $[1 - (\text{min. cladding dia} \div \text{max. cladding dia.})] \times 100$	<1.0%
Proof/Tensile Test	345 MPa, min.
Attenuation: @ 1310 nm @ 1,550 nm	<0.4 dB/km <0.4 dB/km
Attenuation at the Water Peak	<2.1 dB/km @ 1383 $\pm 3$ nm
Bandwidth at 1310 nm	N/A
Chromatic Dispersion: Zero Dispersion Wavelength	1301.5 to 1321.5 nm
Zero Dispersion Slope	<0.092 ps/(nm <sup>2</sup> *km)
Maximum Dispersion:	<3.3 ps/(nm*km) for 1285 - 1330 nm <18 ps/(nm*km) for 1550 nm
Cut-Off Wavelength	<1250 nm
Numerical Aperture (measured in accordance with EIA-455-47 (FOTP-47))	N/A
Mode Field Diameter (Petermann II)	9.3 $\pm 0.5 \mu\text{m}$ at 1300 nm 10.5 $\pm 1.0 \mu\text{m}$ at 1550 nm

#### 10-4.02C COLOR CODING

Optical fibers shall be distinguishable from others in the same buffer tube by means of color coding according to the following:

1. Blue (BL)	7. Red (RD)
2. Orange (OR)	8. Black (BK)
3. Green (GR)	9. Yellow (YL)
4. Brown (BR)	10. Violet (VL)
5. Slate (SL)	11. Rose (RS)
6. White (WT)	12. Aqua (AQ)

Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors according to the same table listed above for fibers.

The colors shall be targeted in accordance with the Munsell color shades and shall meet EIA/TIA-598 "Color Coding of Fiber Optic Cables."

The color formulation shall be compatible with the fiber coating and the buffer tube filling compound, and be heat stable. It shall not fade or smear or be susceptible to migration and it shall not affect the transmission characteristics of the optical fibers and shall not cause fibers to stick together.

#### 10-4.02D CABLE CONSTRUCTION

**General.--** The fiber optic cable shall consist of, but not be limited to, the following components:

- A. Buffer tubes
- B. Central member
- C. Filler rods
- D. Stranding
- E. Core and cable flooding
- F. Tensile strength member
- G. Ripcord
- H. Outer jacket

**Buffer tubes.--** Loose buffer tubes shall provide clearance between the fibers and the inside of the tube to allow for expansion without constraining the fiber. The fibers shall be loose or suspended within the tubes and shall not adhere to the inside of the tube. Each buffer tube shall contain a maximum of 12 fibers.

The loose buffer tubes shall be extruded from a material having a coefficient of friction sufficiently low to allow free movement of the fibers. The material shall be tough and abrasion resistant to provide mechanical and environmental protection of the fibers, yet designed to permit safe intentional "scoring" and breakout, without damaging or degrading the internal fibers.

Buffer tube filling compound shall be a homogenous hydrocarbon-based gel with anti-oxidant additives and used to prevent water intrusion and migration. The filling compound shall be non-toxic and dermatologically safe to exposed skin. It shall be chemically and mechanically compatible with all cable components, non-nutritive to fungus, non-hygroscopic and electrically non-conductive. The filling compound shall be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. An absorbent polymer, which fills voids and swells to block the ingress of water can be used instead of the gel fill.

Buffer tubes shall be stranded around a central member by a method that will prevent stress on the fibers when the cable jacket is placed under strain, such as the reverse oscillation stranding process.

Each buffer tube shall be distinguishable from other buffer tubes in the cable by means of color coding as specified above for fibers.

**Central Member.--** The central member, which functions as an anti-buckling element, shall be a glass reinforced plastic rod with similar expansion and contraction characteristics as the optical fibers and buffer tubes. To provide the proper spacing between buffer tubes during stranding a linear overcoat of polyethylene may be applied to the central member to achieve the optimum diameter.

**Filler rods.--** Fillers may be included in the cable to lend symmetry to the cable cross-section where needed. Filler rods shall be solid medium or high density polyethylene. The diameter of filler rods shall be the same as the outer diameter of the buffer tubes.

**Stranding.--** Completed buffer tubes shall be stranded around the overcoated central member using stranding methods, lay lengths and positioning such that the cable shall meet mechanical, environmental and performance specifications. A polyester binding shall be applied over the stranded buffer tubes to hold them in place. Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

**Core and Cable Flooding.--** The cable core interstices shall contain a water blocking material to prevent water ingress and migration, the water blocking material shall be either a polyolefin based compound or an absorbent polymer, which fills voids and swells to block the ingress of water. The flooding compound shall be homogeneous, non-hygroscopic, electrically non-conductive, and non-nutritive to fungus. The compound shall also be nontoxic, dermatologically safe and compatible with all other cable components.

**Tensile Strength Member.--** Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass which shall be helically stranded evenly around the cable core and shall not adhere to other cable components.

**Ripcord.--** The cable shall contain at least one ripcord under the jacket for easy sheath removal.

**Outer jacket.--** The jacket shall be free of holes, splits, and blisters and shall be medium or high density polyethylene (PE), or medium density cross-linked polyethylene with minimum nominal jacket thickness of  $1000 \pm 70 \mu\text{m}$ . Jacketing material shall be applied directly over the tensile strength members and flooding compound and shall not adhere to the aramid strength material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be marked with the manufacturer's name, the words "Optical Cable", the number of fibers, "SM", year of manufacture, and sequential measurement markings every meter. The actual length of the cable shall be within  $-0/+1$  percent of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm.

#### **10-4.02E GENERAL CABLE PERFORMANCE SPECIFICATIONS**

The F/O cable shall withstand water penetration when tested with a one meter static head or equivalent continuous pressure applied at one end of a one meter length of filled cable for one hour. No water shall leak through the open cable end. Testing shall be done in accordance with EIA-455-82 (FOTP-82), "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable."

A representative sample of cable shall be tested in accordance with EIA-455-81A (FOTP-81), "Compound Flow (Drip) Test for Filled Fiber Optic Cable". No preconditioning period shall be conducted. The cable shall exhibit no flow (drip or leak) at  $65^\circ\text{C}$  as defined in the test method.

Crush resistance of the finished F/O cables shall be 220 N/cm applied uniformly over the length of the cable without showing evidence of cracking or splitting when tested in accordance with EIA-455-41 (FOTP-41), "Compressive Loading Resistance of Fiber Optic Cables". The average increase in attenuation for the fibers shall be  $<0.10 \text{ dB}$  at 1550 nm (singlemode) for a cable subjected to this load. The cable shall not exhibit any measurable increase in attenuation after removal of load. Testing shall be in accordance with EIA-455-41 (FOTP-41), except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes.

The cable shall withstand 25 cycles of mechanical flexing at a rate of  $30 \pm 1$  cycles/minute. The average increase in attenuation for the fibers shall be  $<0.20 \text{ dB}$  at 1550 nm (singlemode) at the completion of the test. Outer cable jacket cracking or splitting observed under 10x magnification shall constitute failure. The test shall be conducted in accordance with EIA-455-104 (FOTP-104), "Fiber Optic Cable Cyclic Flexing Test," with the sheaf diameter a maximum of 25 times the outside diameter of the cable. The cable shall be tested in accordance with Test Conditions I and II of (FOTP-104).

Impact testing shall be conducted in accordance with EIA-455-25 (FOTP-25) "Impact Testing of Fiber Optic Cables and Cable Assemblies." The cable shall withstand 20 impact cycles. The average increase in attenuation for the fibers shall be  $<0.20 \text{ dB}$  at 1550 nm (singlemode). The cable jacket shall not exhibit evidence of cracking or splitting.

The finished cable shall withstand a tensile load of 2700 N without exhibiting an average increase in attenuation of greater than 0.20 dB (singlemode). The test shall be conducted in accordance with EIA-455-33 (FOTP-33), "Fiber Optic Cable Tensile Loading and Bending Test." The load shall be applied for one-half hour in Test Condition II of the EIA-455-33 (FOTP-33) procedure.

#### **10-4.02F PACKAGING AND SHIPPING REQUIREMENTS**

Documentation of compliance to the required specifications shall be provided to the Engineer prior to ordering the material. The cable manufacturer shall be 1509001 registered.

Attention is directed to "Fiber Optic Testing," elsewhere in these special provisions.

The completed cable shall be packaged for shipment on reels. The cable shall be wrapped in a weather and temperature resistant covering. Both ends of the cable shall be sealed to prevent the ingress of moisture.

Each end of the cable shall be securely fastened to the reel to prevent the cable from coming loose during transit. Four meters of cable length on each end of the cable shall be accessible for testing.

Each cable reel shall have a durable weatherproof label or tag showing the manufacturer's name, the cable type, the actual length of cable on the reel, the Contractor's name, the contract number, and the reel number. A shipping record shall also be included in a weatherproof envelope showing the above information and also include the date of manufacture, cable characteristics (size, attenuation, bandwidth, etc.), factory test results, cable identification number and any other pertinent information.

The minimum hub diameter of the reel shall be at least thirty times the diameter of the cable. The F/O cable shall be in one continuous length per reel with no factory splices in the fiber. Each reel shall be marked to indicate the direction the reel should be rolled to prevent loosening of the cable.

Installation procedures and technical support information shall be furnished at the time of delivery.

#### 10-4.03 FIBER OPTIC LABELING

##### Abbreviation:

HUB	HUB.X
VAULT	VXX.X
CAMERA	CXX.X

The X's denote the kilopost of the above elements.

##### Pigtails:

Cable Type	From	To	Fiber No.
X	- XXX.X	-XXX.X	-XX

A label shall be placed on each pigtail near the connector showing the point of origin of the link and the termination of the link. A label with the fiber number being spliced shall be placed on the end of the pigtail near the splice.

Example labeling: C-HUB.A-C44.5-10.

##### Splice Vaults:

Cable Type	From	To
X	-XXX.X	-XXX.X

A label shall be placed on Type C and D cables as they enter and exit each splice vault.. A label shall be placed on the cable inside the closed circuit television, ramp meter, vehicle detection station and TOS assemblies.

Example labeling: C-HUB.A-HUB.E

Example labeling: D-C044.5-V044.8

**Jumpers:**

Equipment From			Equipment To		
ID	No.	by	ID	No.	by

Both ends shall be labeled near the connector. The label shall be the same on both ends and denote where the ends of the jumper are plugged into.

**Splice Trays:**

A label shall be placed on each splice tray explaining the splices in the tray.

**10-4.04 CABLE INSTALLATION**

Installation procedures shall be in conformance with the procedures specified by the cable manufacturer for the specific cable being installed. The Contractor shall submit the manufacturer's recommended procedures for pulling fiber optic cable at least 20 working days prior to installing cable. Mechanical aids may be used, provided that a tension measuring device, and a breakaway swivel are placed in tension to the end of the cable, and the allowable tension does not exceed the manufacturers recommended pulling tension.

During cable installation, the bend radius shall be maintained at a minimum of twenty times the outside diameter of the cable. The cable grips for installing the fiber optic cable shall have a ball bearing swivel to prevent the cable from twisting during installation.

F/O cable shall be installed using a cable pulling lubricant recommended by the F/O cable and/or innerduct manufacturer and a non-abrasive pull tape conforming to the provisions described under "Conduit", elsewhere in these special provisions. Contractor's personnel shall be stationed at each splice vault through which the cable is to be pulled to lubricate and prevent kinking or other damage.

Splicing of Type D cables to Type C cable shall involve only those fibers being spliced as shown on the plans. Cable splices shall be located in splice vaults shown on the plans. A minimum of 36 m of slack shall be provided at each splice vault. Slack shall be divided equally on each side of the F/O splice closure.

The mid-span access method shall be used to access the individual fibers in the distribution cable for splicing to the accessory cable. Cable manufactures recommended procedures and approved tools shall be used when performing a mid-span access. All measures shall be taken to avoid damaging buffer tubes and individual fibers not being used in the mid-span access. The Contractor will be allowed to splice a total of 5 fibers to repair any damage done during mid-span access splicing without penalty. For each additional splice the Contractor will be assessed \$300.00. Any single fiber may not have more than 3 unplanned splices. If the fiber needs to be spliced more than 3 times, the entire length of F/O cable must be replaced at the Contractor's expense.

Following the installation of the cable in innerduct, all duct entrances in cabinets, pullboxes and vaults shall be sealed as described under "Conduit" elsewhere in these special provisions.

Unless shown or provided otherwise, only one F/O cable shall be installed in each innerduct. Pulling a separate F/O cable into a spare duct to replace damaged fiber will not be allowed.

At the Contractor's option, the fiber optic cable may be installed by using the air blown method. If integral innerduct is used, the innerduct splice points or any temporary splices used for installation must withstand a static air pressure of 760 kPa.

The fiber installation equipment shall incorporate a mechanical drive unit or pusher which feeds cable into the pressurized innerduct to provide a sufficient push force on the cable, which is coupled with the drag force created by the high-speed airflow. The unit shall be equipped with controls to regulate the flow rate of compressed air entering the innerduct and any hydraulic or pneumatic pressure applied to the cable. It shall accommodate longitudinally ribbed, or smooth wall innerducts from nominal 15 mm to 50 mm inner diameter. Mid assist or cascading of equipment shall be for the installation of long cable runs. The equipment shall incorporate safety shutoff valves to disable the system in the event of sudden changes in pneumatic or hydraulic pressure.

The equipment shall not require the use of a piston or any other air capturing device to impose a pulling force at the front end of the cable, which also significantly restricts the free flow of air through the innerduct. It shall incorporate the use of a counting device to determine the speed of the cable during installation and the length of the cable installed.

**10-4.05 SPLICING**

Field splices shall be done either in splice vaults or cabinets as shown on the plans. All splices in splice vaults shall be done in splice trays, housed in splice closures. All splices in cabinets shall be done in splice trays housed in ITUs. All splices done in communication hubs shall be done in splice trays housed in FDUs.

Unless otherwise allowed, the F/O cable splices shall be the fusion type. The mean splice loss shall not exceed 0.07 dB per splice. The mean splice loss shall be obtained by measuring the loss through the splice in both directions and then averaging the resultant values.

When splicing selected fiber of two cables, a "mid-span access" method shall be used. The individual fibers shall be looped one full turn within the splice tray to avoid micro bending. A 45 mm minimum bend radius shall be maintained during installation and after final assembly in the optical fiber splice tray. Each bare fiber shall be individually restrained in a splice tray. The optical fibers in buffer tubes and the placement of the bare optical fibers in the splice tray shall be such that there is no discernible tensile force on the optical fiber.

All splices shall be protected with a metal reinforced thermal shrink sleeve.

#### **10-4.06 SPLICE CLOSURES AND SPLICE TRAYS**

The F/O field splices shall be enclosed in splice closures which shall be complete with splice organizer trays, brackets, plugs, clips, cable ties, seals and sealants, as needed. The splice closure shall be suitable for a direct burial or pull box application. The manufacturer's installation instructions shall be supplied to the Engineer prior to the installation of any splice closures. Location of the splice closures shall be where a splice is required as shown on the plans, designated by the Engineer, or described in these special provisions

The splice closure shall conform to the following:

- non filled thermoplastic case
- pressurizable, rodent proof, water proof, re-enterable and moisture proof
- expandable from 2 cables per end to 8 cables per end by using adapter plates
- cable entry ports shall accommodate 10 mm to 25 mm diameter cables
- multiple grounding straps
- accommodate up to 8 splice trays
- suitable for "butt" or "through" cable entry configurations
- place no stress on finished splices within the splice trays

Splice closures shall be bolted to the side wall of the splice vault.

Splice trays in the splice closures shall conform to the following:

- accommodate up to 24 fusion splices
- place no stress on completed splices within the tray
- accommodate "butt" or "through" splicing applications
- accommodate up to 8 buffer tubes, holding up to 48 fibers
- stackable with a snap-on hinge cover
- buffer tubes securable with channel straps
- contain fiber retention strips that accommodates either fusion or mechanical splices
- must be labeled per these special provisions

#### **10-4.07 PASSIVE CABLE ASSEMBLIES AND COMPONENTS**

The F/O cable assemblies and components shall be compatible components, designed for the purpose intended, and manufactured by a company regularly engaged in the production of material for the fiber optic industry. All components or assemblies shall be best quality, non-corroding, with a design life of at least 20 years.

#### **10-4.08 FIBER OPTIC CABLE TERMINATIONS**

##### **10-4.08A DISTRIBUTION INTERCONNECT PACKAGE**

**General.--** Distribution involves connecting the fibers to the locations shown on the plans. The distribution interconnect package consists of FDU and/or ITUs with connector panels, couplers, splice trays, fiber optic pigtails and jumpers. The distribution interconnect package shall be assembled and tested by a company who is regularly engaged in the assembly of these packages. Attention is directed to "Fiber Optic Testing" elsewhere in these special provisions. All distribution components shall be products of the same manufacturers, who are regularly engaged in the production of these components, and the respective manufacturers shall have quality assurance programs.

#### 10-4.08B FIBER OPTIC CABLE ASSEMBLIES AND PIGTAILS

**General.--** Cable assemblies (jumpers and pigtails) shall be products of the same manufacturer. The cable used for cable assemblies shall be made of fiber meeting the performance requirements of these special provisions for the F/O cable being connected.

**Pigtails.--** Pigtails shall be of simplex (one fiber) construction, in 900  $\mu\text{m}$  tight buffer form, surrounded by aramid for strength, with a PVC jacket with manufacturer identification information, and a nominal outer jacket diameter of 3 mm. Singlemode simplex cable jackets shall be yellow in color. All pigtails shall be factory terminated and tested and at least one meter in length.

**Jumpers.--** Jumpers may be of simplex or duplex design. Duplex jumpers shall be of duplex round cable construction, and shall not have zipcord (siamese) construction. All jumpers shall be at least 2 meter in length, sufficient to avoid stress and allow orderly routing.

The outer jacket of duplex jumpers shall be colored according to the singlemode color (yellow) specified above. The two inner simplex jackets shall be contrasting colors to provide easy visual identification for polarity.

**SC Connectors.--** SC type connectors shall meet the requirements of EIA/TIA-568A except as specified below. SC connector body housings shall be of polymer construction.

All F/O connectors shall have a 2.5 mm diameter, Zirconia Ceramic, SC connector ferrule with a PC (Physical Contact) pre-radius tip.

The SC connector operating temperature range shall be  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ . Insertion loss shall not exceed 0.4 dB for singlemode and the return reflection loss on connectors shall be at least 50 dB. Connection durability shall be less than a 0.2 dB change per 500 mating cycles per EIA-455-21A (FOTP-21). All terminations shall provide a minimum 222N pullout strength. Factory test results shall be documented and submitted to the Engineer prior to installing any of the connectors. Singlemode connectors shall have a blue color on the shroud and a white color on the boot in accordance with the Munsell color shades specified elsewhere, that renders them easily identifiable.

Field terminations shall be limited to splicing of adjoining cable ends and/or cables to SC pigtails.

**ST Connectors.--** ST type connectors shall meet the requirements of EIA/TIA-568A except as specified below. ST connector body housings shall be of polymer construction.

All F/O connectors shall have a 2.5 mm diameter, Zirconia Ceramic, ST connector ferrule with a PC (Physical Contact) pre-radius tip.

The ST connector operating temperature range shall be  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ . Insertion loss shall not exceed 0.5 dB, for either multimode or singlemode, and the return reflection loss on singlemode connectors shall be at least 40 dB. Connection durability shall be less than a 0.2 dB change per 500 mating cycles per EIA-455-21A (FOTP-21). All terminations shall provide a minimum 222N pullout strength. Factory test results shall be documented and submitted to the Engineer prior to installing any of the connectors. Singlemode connectors shall have a blue color on the shroud and a white color on the boot in accordance with the Munsell color shades specified elsewhere, that renders them easily identifiable.

Field terminations shall be limited to splicing of adjoining cable ends and/or cables to ST pigtails.

**SC Couplers.--** The SC couplers shall be made of polymer construction that is consistent with the material forming the associated SC connector body. The design mechanism for mounting the couplers to the ITU connector panel may be achievable using metal clips or fasteners but shall coincide with the ITU panel punch-outs.

All coupler sleeves shall be of the cylinder split ceramic or clover leaf design.

The temperature operating range for couplers shall be the same as that specified for the SC connectors.

**ST Couplers.--** The ST couplers shall be made of polymer construction that is consistent with the material forming the associated ST connector body. The design mechanism for mounting the couplers to the ITU connector panel may be achievable using metal clips or fasteners but shall coincide with the ITU panel punch-outs.

All coupler sleeves shall be of the cylinder split ceramic or clover leaf design.

The temperature operating range for couplers shall be the same as that specified for the ST connectors.

**Splice Trays.--** Splice trays must accommodate a minimum of 12 fusion splices. They must allow for a minimum bend radius of 45 mm. No stress can be placed on the fiber when it is located in its final position. Buffer tubes must be secured to the tray near the entrance of the splice tray to reduce the chance that an inadvertent tug on the pigtail will damage the fiber. Reduced length splice trays will only be allowed in wall mounted type fiber termination units. The splice tray cover must be transparent.

Only one single splice tray may be secured by a bolt through the center of the tray in the ITU. Multiple trays must be securely held in place by a different method.

#### **10-4.08C INTERCONNECT TERMINATION UNIT (ITU)**

The Contractor shall furnish and install all related equipment to interface the rack mount interconnect and termination unit to the incoming fiber optic communications cable and the patchcord fiber optic cable.

The ITU shall be a modular enclosure that provides interconnect capability of one multi-fiber cable to a minimum of 12 single-fiber cable. The ITU shall be environmentally sealed and contain grommets at the cable entrances to prevent any ingress of dirt or moisture. Strain relief shall be provided for the fiber optic cable. The ITU shall contain a splice tray, connector panel and the appropriate number of pigtails which will be fusion spliced to the incoming fiber cable. Each fiber shall be fusion spliced to a pigtail with a factory installed and polished SC connector. Each pigtail shall be labeled and secured onto cable as described elsewhere in these special provisions. Brackets shall be provided to spool the incoming fiber optic cable to minimum of 3 turns before separating out individual fibers to the connector panel.

The ITU shall meet the following physical requirements:

482.6mm rack mountable  
305mm(D) x 45mm(H)

The ITU shall be a metal enclosure with a hinged door. The door shall have a latch or thumbscrew to hold the door in the closed position. An opening shall be provided on the back side of the incoming fiber optic communications cable. Connector panels (for up to 12 SC connectors) shall be provided inside the enclosure. Strain relief shall be provided for the incoming fiber optic cable. A guard shall be provided to protect the patchcord fiber optic cables plugged into this enclosure.

### **10-4.09 FIBER OPTIC TESTING**

#### **10-4.09A GENERAL**

Testing shall include the tests on elements of the passive fiber optic components: (1) at the factory, (2) after installation but prior to connection to any other portion of the system, and (3) during final system testing. The Contractor shall provide all personnel, equipment, instrumentation and materials necessary to perform all testing. The Engineer shall be notified two working days prior to all field tests. The notification shall include the exact location or portion of the system to be tested.

Documentation of all test results shall be provided to the Engineer within 2 working days after the test involved. The Contractor's attention is directed to "As-Builts" elsewhere in these special provisions, regarding the requirements for recording test results.

A minimum of 20 days prior to arrival of the cable at the site, the Contractor shall provide detailed test procedures for all field testing for the Engineer's approval. The procedures shall include the tests involved and how the tests are to be conducted. Included in the test procedures shall be model, manufacturer, configuration, calibration and alignment procedures for all proposed test equipment.

#### **10-4.09B FACTORY TESTING**

Documentation of compliance with the fiber specifications as listed in the Fiber Characteristics Table shall be supplied by the original equipment manufacturer. After cabling, before shipment but while on the shipping reel, 100 percent of all fibers shall be tested for attenuation. Copies of the results shall be (1) maintained on file by the manufacturer with a file identification number for a minimum of 7 years, (2) attached to the cable reel in a waterproof pouch, and (3) submitted to the Contractor and to the Engineer.

#### **10-4.09C AFTER CABLE INSTALLATION**

After the fiber optic cable has been pulled but before breakout and termination, 100 percent of all the fibers shall be tested with an OTDR for attenuation. Test results shall be recorded, dated, compared and filed with the previous copies of these tests. Copies of traces and test results shall be submitted to the Engineer. If the OTDR test results are unsatisfactory, the F/O cable segment will be unacceptable. The unsatisfactory segment of cable shall be replaced with a new segment, without additional splices, at the Contractor's expense. The new segment of cable shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.



Attenuation tests shall be performed with an OTDR capable of recording and displaying anomalies of 0.02 dB as a minimum. Singlemode fibers (SM) shall be tested at 1310 nm and 1550 nm. Attenuation readings for each direction shall be recorded on the cable data sheet.

The OTDR shall have a printer capable of producing a verifying test trace with fiber identification as shown in Appendix A "Link Loss Budget Work Sheet", numerical loss values, the date and the operator's name. It shall also have a DOS based 89 mmdisk recording capability that has associated software to do comparisons and reproductions on 216 mm x 279 mmpaper, via a personal computer.

#### **10-4.09D OUTDOOR SPLICES**

At the conclusion of all outdoor splices at one location, and before they are enclosed and sealed, all splices shall be tested with the OTDR, in both directions. Splices in singlemode segments shall be tested at 1310 nm and at 1550 nm. Individual fusion splice losses shall not exceed 0.10 dB. Measurement results shall be recorded, dated, validated by the OTDR trace printout and filed with the records of the respective cable runs. Copies of traces and test results shall be submitted to the Engineer. If the OTDR test results are unsatisfactory, the splice shall be unacceptable. The unsatisfactory splice shall be replaced at the Contractor's expense. The new splice shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

#### **10-4.09E DISTRIBUTION INTERCONNECT PACKAGE TESTING AND DOCUMENTATION**

All the components of the passive interconnect package (FDUs, ITUs, pigtails, jumpers, couplers and splice trays) shall comprise a unit from a manufacturer who is regularly engaged in the production of the fiber optic components described.

In developing the distribution interconnect package, each SC, ST and/or SC-ST hybrid termination (pigtail or jumper) shall be tested for insertion attenuation loss with the use of an optical power meter and source. In addition, all singlemode terminations shall be tested for return reflection loss. These values shall meet the loss requirements specified earlier and shall be recorded on a tag attached to the pigtail or jumper.

Once assembly is complete, the manufacturer shall visually verify that all tagging, including loss values, is complete. Then as a final quality control measure, the manufacturer shall do an "end to end" optical power meter/light source test from pigtail end to jumper lead end to assure continuity and overall attenuation loss values.

#### **10-4.09F FIBER OPTIC SYSTEM DESIGN CRITERIA**

The design system gain margin shall be at least 6 dB for each and every link. If the design system gain margin is less than 6 dB, the Engineer shall be notified and informed of the Contractor's plan to meet the design requirement. The Design System Gain Margin shall be calculated by subtracting the Total System Loss of each link (from Cable Verification Worksheet elsewhere in these special provisions) from the Total System Gain (measured during equipment testing).

#### **10-4.09G ACTIVE COMPONENT TESTING**

The transmitters and receivers shall be tested with a power meter and light source, to record the transmitter average power (dBm) and receiver sensitivity (dBm). These values shall be recorded in the Link Loss Budget Worksheet shown in Appendix A.

**10-4.09H SYSTEM VERIFICATION AT COMPLETION**  
**OTDR Testing.--** Once the passive cabling system has been installed and is ready for activation, 100 percent of the fibers shall be tested with the OTDR for splice loss and attenuation. Testing of fiber links shall be completed in such a way, to show the loss of each connector, in the OTDR trace. Test results shall be recorded, dated, compared and filed with previous copies. Copies of traces and test results shall be submitted to the Engineer. If the OTDR test results are unsatisfactory the link shall be replaced at the Contractor's expense. The new link shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to the Engineer.

**Installed System Cable Verification Worksheet.--** The Cable Verification Worksheet shown in Appendix A shall be completed for each link in the fiber optic system, using the data gathered throughout the installation process. The completed worksheets shall be submitted to the Engineer for approval.

**Power Meter and Light Source.--** At the conclusion of the final OTDR testing, 100 percent of all fiber links shall be tested end to end with a power meter and light source, in accordance with EIA Optical Test Procedure 171 and in the same wavelengths specified for the OTDR tests. These tests shall be conducted in both directions. Test results shall be recorded on the Cable Verification Worksheet, compared and proven to be within the design link loss budgets, and filed with the other recordings of the same links.

**Test Failures.--** If during any of these system verification tests, the results prove to be unsatisfactory, the F/O cable will not be accepted. The unsatisfactory segments of cable shall be replaced with a new segment of cable at the Contractor's expense. The new segment of cable shall undergo the same testing procedure to determine acceptability. Copies of the test results shall be submitted to the Engineer. The removal and replacement of a segment of cable shall be interpreted as the removal and replacement of a single contiguous length of cable connecting two splices, two connectors, or a splice and a connector. The removal of only the small section containing the failure and therefore introducing new unplanned splices, will not be allowed.

#### **10-4.10 PAYMENT**

Full compensation for conforming to the provisions in this section shall be considered as included in the prices paid for the various contract items of work involved and no additional compensation will be allowed therefor.

## APPENDIX A

### Cable Verification Worksheet

Contract No. \_\_\_\_\_

Contractor: \_\_\_\_\_

Operator: \_\_\_\_\_

Date: \_\_\_\_\_

Link Number: \_\_\_\_\_

Fiber Number: \_\_\_\_\_

Test Wavelength (Circle one): 1310      1550

Location of Fiber Ends:

End 1: \_\_\_\_\_ End 2: \_\_\_\_\_

1. OTDR Test Results:

A. Forward Loss \_\_\_\_\_ dB

B. Reverse Loss: \_\_\_\_\_ dB

C. Average Loss  $[2A + 2B]/2$ : \_\_\_\_\_ dB

2. Power Meter and Light Source Test Results:

A. Forward Loss: \_\_\_\_\_ dB

B. Reverse Loss: \_\_\_\_\_ dB

C. Average Loss  $[2A + 2B]/2$ : \_\_\_\_\_ dB

3. Calculated Fiber Loss:

A. Number of Splices in the Link: \_\_\_\_\_

B. Allowed Link Loss per Splice: \_\_\_\_\_ dB

Total Allowed Loss due to Splices  $(4A * 4B)$ : \_\_\_\_\_ dB

4. Calculated Splice Loss:

C. Number of Splices in the Link: \_\_\_\_\_

D. Allowed Link Loss per Splice: \_\_\_\_\_ dB

E. Total Allowed Loss due to Splices  $(4A * 4B)$ : \_\_\_\_\_ dB

5. Calculated Link Loss:

A. Allowed Connector Loss (for 2 connectors): \_\_\_\_\_ dB

B. Total Link Loss  $(5A + 3C + 4C)$ : \_\_\_\_\_ dB

6. Cable Verification:

A. Compare Power Meter Average Loss to Calculated Link Loss  $(2C - 5B)$ :

If the value on line 6A is greater than zero, the link has failed the Test. See Test Failures elsewhere in these special provisions.

To Be Completed By Caltrans:

Resident Engineer's Signature: \_\_\_\_\_

Cable Link Accepted By: \_\_\_\_\_

Contract No. «Dist»-«Contract\_No»

## SECTION 10-5. CLOSED CIRCUIT TELEVISION EQUIPMENT

### 10-5.01 GENERAL

Closed circuit television (CCTV) System shall conform to all rules and regulations of the Federal Communications Commission and shall conform to the provisions in Section 86, "Signals, Lighting and Electrical Systems," of the Standard Specifications and these special provisions.

Each CCTV system shall consist of a CCTV Camera Assembly, Type 334-CCTV Cabinet Assembly and Camera pole.

### 10-5.02 CLOSED CIRCUIT TELEVISION (CCTV) CAMERA ASSEMBLY

Closed circuit television Camera assembly shall consist of the following:

- 1-CCTV camera
- 1-camera lens
- 1-environmental enclosure
- 1-pan and tilt drive unit

The Contractor shall perform a functional test to verify that the unit works in accordance with the manufacturer's specifications before installing the assembly. Details of the camera and operational elements shall be provided by the Contractor to the Engineer with the material submittals.

#### 10-5.02A CCTV CAMERA

The CCTV camera shall meet the following requirements:

Parameter	Specification
Camera format size	8.5mm (1/3 inch)
Pick-up device	Color CCD, interline transfer
Active pixels	768(H) x 494(V) (minimum)
Horizontal resolution	460 television lines (minimum)
Minimum Illumination (at 3200_ K faceplate illumination)	Full video output: 6.5 lux (AGC off) 80% video: 0.5 lux (AGC on)
Signal to Noise Ratio-Minimum	48 dB at 1.0 V peak to peak (AGC off)
Output Signal	Standard color NTSC video signal 1.0 V peak to peak at 75 Ohms
Video Output Connector	Quick disconnect BNC on rear of camera
Operating voltage	115 VAC $\pm 15\%$ , 60 Hz $\pm 5\%$ (12 to 24 VAC or VDC with 115 VAC adapter is acceptable)
Power consumption	10.0 W (maximum)
Camera Mount	6.35mm - 20 tap threads
Lens mount	"C" mount
Operating temperature	-10° C. to 50° C. (minimum range)
Maximum dimensions	70mmH x 70mmW x 216mm L
Maximum camera weight	.726 kg

The CCTV Camera shall be a color interline CCD type with Digital Signal Processing (DSP). The CCTV Camera shall, when directed to by an operator on the remote IBM compatible personal computer running the camera control program, display a on-screen menu of current DSP settings that are adjustable by the operator.

The camera shall be designed for use at low light levels having a wide dynamic range and minimal blooming and transfer smear characteristics.

The camera shall incorporate Automatic Gain Control (AGC) circuitry to provide for compensation at low light levels. Automatic light range circuits shall be included to provide compensation for variations in scene brightness.

The camera, or a separate pressure sensor in the environmental enclosure, shall be capable of displaying an alarm message on the 20-inch CCTV or computer monitors in the TMC indicating a loss of pressure in the environmental enclosure.

The camera shall have user selectable shutter speeds of from 1/60 second to 1/10,000 second with a minimum of 8 different speeds. The shutter speed shall be adjustable at a remote site on an IBM compatible personal computer running the camera control software.

The camera shall operate from an EIA Standard RS-170 sync as provided by an internal integrated sync generator and phase lock loop circuit to synchronize the camera to power line zero crossing.

Externally accessible controls shall be covered or protected to prevent accidental adjustment.

The camera shall include any required power supply/adaptor equipment to allow operation from an input voltage of 115 VAC  $\pm 15\%$ , 60 Hz  $\pm 5\%$ .

#### 10-5.02B CAMERA LENS

The camera lens shall be one of the following two formats:

Format	Maximum Focal Length
16.9 mm (2/3 inch)	115 +/- 5mm
12.7 mm (1/2 inch)	120 +/- 5mm

The camera lens shall meet the following requirements:

Parameter	Specification
Aperture Range	F1.8 to T1800 (minimum)
Zoom Range	10:1 (minimum range)
Iris	Automatic with Manual Override
View Angle at with a 8.5mm CCD camera at maximum focal length	Horizontal: 2.4° (maximum) Vertical: 1.8° (maximum)
Operating Voltage	5, 9 or 12 VDC
Power Consumption	1 Watt (maximum)
Operating Temperature	-10° C. to 50° C. (minimum range)
Maximum Dimensions	96mm(H) x 121mm(W) x 184mm(L)
Lens Mount	"C" mount
Maximum Lens Weight	1.81kg.

The lens shall have a neutral density spot filter.

Power interruption protection shall be provided to close the lens iris in case of power loss and the lens shall be held closed by a delay circuit for a minimum of 5 seconds during power start-up.

Lens elements shall be glass.

The lens shall be supplied with zoom/focus preset position potentiometers.

The lens shall be designed to prevent bright light "flare" caused by indirect sunlight outside the angle of view of the lens affecting the viewed scene.

The lens shall be supplied with a matching cable, or connector to connect the auto iris feature to the camera body.

Said lens shall have focal optics such that when distant objects are brought into focus they remain in focus after zooming in on them.

A telescopic converter or extender shall not be used to achieve required focal length range.

#### 10-5.02C ENVIRONMENTAL ENCLOSURE

The enclosure shall be pressurized using 34.5 kPa dry nitrogen and have a Schraeder valve for pressurizing. A pressure relief valve with a 138 kPa Parating shall be provided to protect the enclosure from overcharging.

The enclosure shall have provisions for internally mounting the assembled CCTV camera and lens, and shall have sufficient internal dimensions to house the assembled CCTV camera and lens and all internal wiring. A single sealed, multi-pin connector shall be provided on the rear of the enclosure for the connection of all external video, power and control cabling. A sealed and weatherproof mating connector shall be provided with pinout description.

The enclosure shall include an internal thermostatically controlled heater assembly to minimize external faceplate condensation.

The enclosure shall meet Military Specification MIL-STD-810D or MIL-E-5400T, para. 3.2.24.4 for humidity.

All CCTV camera assemblies shall be plug compatible and interchangeable such that technicians can exchange CCTV camera assemblies in the field.

The enclosure shall include a sun shroud to provide protection from direct solar radiation. The enclosure shall include an adjustable mount and be physically compatible with the pan/tilt unit.

The enclosure shall have a maximum weight of 20.4kg., excluding CCTV camera and lens. The minimum operating temperature range of the enclosure shall be -17° C. to 50° C.

Desiccant shall be provided inside the enclosure to remove any residual moisture that may get trapped in the enclosure as a result of camera and lens installation.

A humidity indicator shall be factory installed in the enclosure. It shall be visible through the camera window to properly indicate moisture accumulation inside the enclosure.

A cradle mount shall be positioned anywhere around the entire circumference of the enclosure body or its full length. The cradle shall be attached to the body using two stainless steel straps supplied with the enclosure. Said enclosure shall be UL listed.

#### **10-5.02D PAN TILT DRIVE UNIT**

The pan and tilt drive unit shall be fully compatible with the CCTV camera assembly and have a cableguard.

The travel angle of the pan and tilt drive unit shall be from 0 degrees to 355 degrees in the horizontal (pan) mode, and from +60 degrees upward to -90 degrees in the vertical (tilt) mode with the camera assembly attached.

The unit shall be fully load rated to accept the CCTV camera assembly under wind load conditions of 40.23 m/s. It shall also be load rated to at least 22.68Kg. within a temperature range of -17° C to 60° C.

All cable connectors shall be fully weather protected type.

Pan and tilt movements shall both be worm gear driven to minimize backlash and to eliminate wind drift. The worm shall be made from stainless steel and shall be ground and polished, and the worm gear shall be manufactured from a non-metallic material. This assembly shall not require any type of lubrication and shall be adjustable to compensate for wear.

Access into pan/tilt for routine maintenance or adjustments of any kind shall not require the removal of the pan and tilt from the installation site, nor removal of the camera enclosure from the pan/tilt unit. Access cover shall be readily removable regardless of the tilt position.

Pan and tilt movement shall have the ability to be automatically directed to a specified preset position and also to be manually controlled. The pan and tilt unit shall be capable of returning (feedback) voltages to indicators that reflect azimuth and elevation position of pan/tilt. Pan/tilt shall be controllable by either a hardwire controller with position readouts or by a control signal transmission system. (Javelin Omni Quest or Omni Quic control system or equivalent).

External body components shall be manufactured from aluminum which have been anodized to prevent oxidation and corrosion.

The pan and tilt drive unit shall instantaneously reverse motor action. The pan and tilt drive unit shall incorporate dynamic braking to prevent drift. The unit shall pan at a nominal speed of 9 degrees per second, and a nominal tilt at 3 degrees per second. The speed of the unit shall be confirmed prior to installation.

Mounting holes shall be located to provide for securely mounting the pan and tilt drive unit to the mounting bracket for installations on pole tops, or other support structures identified on the plans. Provision shall be made for mounting the camera assembly securely and to prevent hardware from becoming loose.

The dimensions of the pan and tilt drive unit shall not exceed 381mm (W) x 457mm(H) x 229mm(D). The weight of the pan and tilt drive unit shall not exceed 27.2kg.

The pan and tilt drive unit shall operate on an input voltage of 120VAC, 50/60 Hz supplied by the ACU. The pan and tilt drive unit motors shall have a nominal power consumption of less than 100 watts with a peak load not to exceed 4 times the nominal loading. The pan and tilt drive unit shall have internal overload protection.

The cableguard shall consist of an aluminum rod and shall be complete with attaching hardware. The cableguard shall provide protection from abrasion of the cable harness.

The pan and tilt range settings shall be individually set by the Contractor and approved by the Engineer at each camera site during installation.

After installation and with the CCTV camera assembly installed, the pan and tilt drive unit shall be panned 355 degrees and tilted over the full vertical range, controlled from the camera control cabinet and communication hub structure.

### 10-5.03 TYPE 334-CCTV CABINET ASSEMBLY.

Each Type 334-CCTV Cabinet Assembly shall consist of the following:

- A. 1-Type 334-CCTV cabinet
- B. 1-Auxiliary control unit (ACU) – rack mount
- C. 1-Multiple outlet strip - rack mount
- D. 1-Interconnect wiring
- E. 1-TCVR transmitter
- F. 1-Interconnect termination unit- rack mount (ITU)

#### 10-5.03A TYPE 334-CCTV CABINET

Type 334-CCTV cabinet shall consist of the following:

Housing  
Mounting cage  
Power distribution assembly  
Thermostatically controlled fan

All necessary mounting hardware and wiring, foundation and anchor bolts and other equipment, as shown on the plans and specified in these special provisions

The housing and the mounting cage shall conform to those of the Model 334 cabinet provisions of the "Traffic Signal Control Equipment Specifications" (TSCES) issued by the State of California, Department of Transportation, and to all addendum thereto current at the time of project advertising. Police panel however, is not required.

Foundations for Type 334-CCTV cabinet housing shall conform to the details on Standard Plan ES-3C for Model 332 and 334 Cabinets.

The power distribution assembly shall consist of the following: one 30 A, 120 V minimum, single pole main breaker; three 15 A, 120 V minimum, single pole secondary breakers; eight standard 117 VAC receptacles; and one duplex, 3 prong, NEMA Type 5-15R grounded utility type outlet. The power distribution assembly shall protect the equipment powered by the assembly from power transients. Over voltage protection shall be provided for the power distribution assembly and shall contain as a minimum, a surge arrestor, which shall reduce the effect of power line voltage transients and be rated as follows:

Recurrent Peak Voltage	184 V
Energy Rating (Minimum)	20 J
Power Dissipation, Average	0.85 W
Peak Current for pulses less than 7 microseconds	1250 A
Stand-by Current for 60 Hz Sinusoidal	1 mA or less

The thermostatically controlled fan shall provide 4.25 cubic meter per minute of ventilation. The fan shall be activated when the temperature inside the cabinet exceeds 24° C and shut off when the temperature is less than 18° C. All vents shall be filtered.

All cabinet assemblies shall be tested to demonstrate the correct function of all controls in the presence of the Engineer.

#### **SURGE PROTECTION**

The Contractor shall furnish and install AC/Dataline Protection unit in the Model 334-CCTV cabinets with the following specifications:

The unit shall have diagnostic circuitry and diagnostic lamps indicating:

LINE OK  
LINE FAULT  
PROTECTION PRESENT

Shall meet UL 1449, UL 1283 and UL 497A specifications.

The AC/Dataline Protector shall be rated as follows:

## AC PROTECTION

Maximum Energy Absorption: 720 Joules  
High Voltage Transient Spike Suppression: Up to 36000 Amperes Spikes.  
Transient Response Time: instantaneous (0 Ns.)  
Protection Modes: All 3: H-N, H-G, N-G  
High Frequency Noise Suppression: Up to 80 db from 50 KHz to 1,000 MHz  
Rated Current and Load Handling:  
15 Amperes max. (1,800 Watts)  
15 Amperes per socket (1,800 Watts) Rated Voltage: 120-volt AC, 50/60 Hz  
Circuit Breaker 15 ampere  
Receptacles: 6 (NEMA 5-15R)  
Cord: 2 m with grounded 3-prong plug  
Dimensions: 44.45 mm x 82.55 mm x 228.60 mm  
Weight: 1.36 kg  
Product Warranty: Lifetime

## DATALINE PROTECTION

Clamping Voltage: 200 Volts peak  $\pm$  10 percent  
Response Time: 5 nanoseconds  
Energy Rating: 90 Joules  
Peak Transient Input Voltage: 6000 Volts, 10 microseconds  
Input: RJ 11 modular jack (4 m cord included)  
Output: RJ 11 modular jack

### 10-5.03B AUXILIARY CONTROL UNIT

The auxiliary control unit shall be a 482.6 mm rack mounted receiver/driver device that converts data on an RS 232 input to output signals that operate the pan and tilt drive unit and motorized camera lens in the CCTV camera assembly.

The ACU shall operate on 120 VAC, 60 Hz input power and provide the 120 VAC, 60 Hz required for the pan and tilt drive unit and the 5, 9 or 12 VDC required for the motorized camera lens in the CCTV camera assembly.

Built-in diagnostics shall be provided that will permit quick and simple testing of camera functions locally.

The ACU shall be capable of executing preset positions for both the pan and tilt drive unit and motorized lens in the CCTV camera assembly. The presets shall be accurate to 5% of the original set location.

The ACU shall have a programmable source identification generator that allows written messages to be stored in non-volatile memory so that it is retained if supply power is removed from the camera. The message shall be capable of displaying a minimum of 3 lines with a minimum of 20 characters per line.

The ACU shall operate on the existing Caltrans District 08 camera control which is compatible with the existing Caltrans District 08 Javelin model 308, 408 and 508 ACU's.

The auxiliary control unit shall meet the following requirements:

Supply Voltage:	120 $\pm$ 10%, 60 Hz.
Power requirements:	100 watts, maximum.
Mounting:	482.6mm rack mount
Pan/Tilt drive voltage:	24 or 120 VAC, field selectable
Lens drive voltage:	5, 9 or 12 VDC, field selectable
Camera supply voltage:	24 or 120 VAC or 12 VDC field selectable
Preset positions:	8 minimum.
Input data communications format:	RS 232.
Size:	121mm H x 483mm W x 356mm D maximum (fits 5.25" high EIA rack space)
Operating temperature range:	-17°C . to +60°C. minimum range.
Humidity range:	0 to 90% minimum

### 10-5.03C MULTIPLE OUTLET STRIP - RACK MOUNT

One multiple outlet strip - rack mount shall be furnished and installed in each type 334-CCTV cabinet. The multiple outlet strip-rack mount shall conform to the following requirements:

Mounting:	482.6mm rack mount
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Contract No. «Dist»-«Contract\_No»



No. of outlets:	6 or greater
Electrical Rating:	15A, 125VAC, 60Hz
Circuit Breaker:	12A, 125VAC
Max. Surge Current	>6500A
Max. Energy Dissipation:	>210J
Modes of Surge Protection:	Hot-to-Neutral
Clamping Response Time	<one nanosecond
Modes of Noise Protection:	Transverse and Common
Noise Attenuation:	20 to 40 dB
Noise Frequency Range:	150 Khz - 100 Mhz
Type of Cordset:	SJT 14/3

### **10-5.03D INTERCONNECT WIRING**

The interconnect wiring between the CCTV camera assembly / pan tilt unit and the transceiver (TCVR) and the auxiliary control unit (ACU) shall be a composite cable that includes flexible 75 Ohm coaxial cable and control cable.

Connectors shall be in accordance with manufacturers recommendation.

Interconnect wiring and connectors shall be supplied and installed to make the CCTV subsystem completely operational.

Specifications of all cable assemblies, including connectors with strain relief backshells, shall be submitted to the Engineer as part of the shop drawings for review and approval.

Wiring shall run continuous from source to destination without splices.

Cables shall be installed without damaging the conductors, insulation, or jacket. The coaxial cables shall not be kinked or bent tighter than the manufacturer's recommended bending radius.

Sufficient slack shall be provided for equipment movement. The cable shall be secured and protected from physical damage.

All interconnect wiring and connectors shall meet or exceed all necessary standards with regards to voltage, current, and environmental ratings.

Control cable shall be routed from the CCTV camera assembly and pan and tilt drive unit to the ACU and TCVR inside the camera pole. A ground wire shall be provided between the CCTV camera assembly and the camera pole. When interconnect cable is broken out onto a terminal strip, the coaxial cable shall be terminated with a BNC type connector. The BNC type connectors shall be an integral part of the terminal strip.

The cables and connectors shall be installed to allow the camera and lens to be disconnected without removing the environmental camera enclosure and to remove the environmental camera enclosure (including camera) without removing the pan and tilt drive unit.

The Contractor shall be responsible for all testing and documentation required to establish approval and acceptance of the production, installation, and operation of these materials and equipment. The following identifies the specific quality control requirements for this special provision:

The Contractor shall test all cables for continuity and shorts or grounds. Tests on cables with connectors attached (connectorized) shall be performed after installation.

The Contractor shall carry out system integration testing to ensure that the video interface and camera interconnect wiring performs to the specified standards when used in operation with all other devices installed under the contract.

### **10-5.03E CAMERA TRANSCEIVER (TCVR)**

The Contractor shall furnish and install TCVR at the camera site to interface with the CCTV camera assembly, and with the fiber optic cable.

The TCVR shall operate on one singlemode fiber.

The TCVR shall support high quality, simultaneous two-way transmission of camera control data and one-way transmission of camera video over one singlemode fiber. The TCVR shall receive RS 232 data for the auxiliary control unit (ACU) and shall transmit NTSC video from the CCTV camera assembly.

The TCVR video transmission and data receiving format used in the camera junction box shall be compatible with the TCVR video receiving and data transmitting format used in the communications hub structure.

The TCVR may be packaged as one surface mountable module or may be individual components such as a receiver, transmitter and wavelength division multiplexer to combine both data and video onto one singlemode fiber.

Supply voltage shall be 120 VAC  $\pm$ 10%, 60 Hz. Lower voltage units will be acceptable if a UL listed power conversion module is used to adapt from the 120 VAC source.

Power required shall be 50 watts maximum.

Mounting shall be to a flat wall surface.

Operating temperature range shall be from -20° C. to +70° C. minimum range.

Video transmitter section shall meet the following requirements:

Input level:	1 V peak – peak (NTSC composite)
Signal-to-Noise ratio at minimum receiver input:	50 dB minimum
Differential phase (10-90% APL):	3° maximum
Differential gain (10-90% APL):	3% maximum
Frequency response:	100 kHz to 5.5 MHz: ±0.30 dB maximum 5.5 MHz to 8 MHz: ±0.6 dB maximum

RS 232 receiver section shall meet the following requirements:

Data rate: DC to 9.6 kbps minimum

Bit error rate:  $10^{-9}$  maximum

Optical shall meet the following requirements:

Video transmitter shall meet the following requirements:

Operating wavelength: 1300 nm or 1550 nm

Launch power: -14 dBm minimum

Sensitivity (receiver): -28 dBm maximum

Loss budget: 14 dB minimum

Fiber compatibility: 8.3/125 µm singlemode

RS 232 receiver shall meet the following requirements:

Operating wavelength: 1300 nm or 1550 nm

Loss budget: 20 dB

Fiber compatibility: 8.3/125 µm singlemode

Connectors shall meet the following requirements:

Video input: BNC

RS 232: DB-9, DB-15 or DB-25

Optical: Type SC

The TCVR units shall be tested prior to installation to ensure proper operation with the camera control transmitter.

The Contractor shall confirm the operation of the TCVR, after installation, using test equipment which emulates all the functions of the camera control transmitter, and shall document all results and keep test equipment in operation until witnessed and approved by the Engineer.

The Contractor shall confirm equipment placement with the Engineer before installing any equipment.

After installing all TCVR units and the communication system, the Contractor shall demonstrate operation of the camera control system and assign all system parameters using the camera control system located at the communication hub that the CCTV is assigned to.

The camera control system shall be tested for the following functions:

The camera control system shall address all TCVR units and shall operate all remote control functions, i.e. pan/tilt, zoom in/out, focus near/far, set up, and recall up to eight preset positions per remote TCVR address. The response of the camera control system shall appear to be instantaneous.

The Contractor shall demonstrate the camera control system to show that it can access all TCVR units.

**TESTING OF THE CAMERA TRANSCEIVERS.**-- The Contractor shall be responsible for all testing and documentation required for proper installation and operation of the camera transceivers, materials and equipment. The following identifies the specific quality control requirements for both the TCVR and TCVR-CH. The TCVR-CH is described elsewhere.

Prior to installation all transceivers shall be tested. The Contractor shall input a standard level video test signal into the TCVR at the camera site and adjust the optical power output of the TCVR to receive a mid-range optical power level for the TCVR-CH located at the communication hub needed to produce the required video receiver output level. The TCVR-CH's video output shall then be connected to a monitor for viewing with the level adjusted to the mid-range of any output settings. The Contractor shall then qualitatively assess the monitor output. Video shall be of high quality with good color and no image ghosting. The signal-to-noise ratio and signal-to-low frequency noise ratio shall be measured and recorded. No optical attenuation devices shall be used to reduce optical signals to required operating range. All indicators shall be verified to function correctly.

#### **10-5.03F RACK MOUNT INTERCONNECT AND TERMINATION UNIT (ITU)**

The Contractor shall furnish and install all related equipment to interface the rack mount interconnect and termination unit to the incoming fiber optic communications cable and the patchcord fiber optic cable.

Attention is directed to Interconnection and Termination Unit (ITU) described elsewhere in these special provisions.

#### **10-5.03G CAMERA POLE**

Sheet steel shall have a minimum yield of 331 MPa. Modifications for hand hole, connector bracket and strain relief shall be made as shown on the plans.

Camera pole type is CCTV45.

#### **10-5.04 PAYMENT**

The contract lump sum price paid for closed circuit television system shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, including CCTV Camera Assembly, Type 334- CCTV Cabinet Assembly and Camera Pole including foundation, with equipment as shown on the plans and described in these special provisions and for doing all the work involved in installing closed circuit televisions assembly, complete in place, including CCTV Camera Assembly, Type 334-CCTV Cabinet Assembly and Camera Pole with equipment as shown on the plans and described in these special provisions, any ancillary or incidental items required to provide full equipment operation at each site, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

### **SECTION 10-6. COMMUNICATION EQUIPMENT**

#### **10-6.01 GLOSSARY**

APD	Avalanche Photodetector.
ADPCM	Adaptive Differential Pulse Code Modulation.
ALBO	Automatic Line Buildout. ALBO provides automatic cable equalization in T1 span-line interface equipment.
AMI	Alternate Mark Inversion.
AT&T	American Telephone and Telegraph Company.
B7	Binary 7.
B8ZS	Binary 8 Zero Substitution. A technique that modifies the alternate mark inversion encoding to ensure pulse density without altering the customer.
BER	Bit error rate.
BERTS	Bit error rate test set.
bps	bits per second.
CCITT	Consultative Committee on International Telegraphy and Telephony.
CGA	Carrier Group Alarm. A service alarm showing out-of-frame (OOF) conditions in the multiplexer.
CRC	Cyclic Redundancy Check.
D-4	A T1 framing format for channel bank operation.
DACS	Digital Access Cross connect System.
DDS	Digital Data System. DDS is a private line digital service provided by the Public Telephone Network. It supports data rates at 2400, 4800, 9600 and 56,000 bits per second.
DS0-A	A process where a subrate signal (2.4, 4.8, 9.6, 19.2 or 56 kbps) is repeated 20, 10 or 5 times carried over a signal DS0.
DS0-B	A process performed by a subrate multiplexer where twenty 2.4 kbps, ten 4.8 kbps or five 9.6 kbps signals are multiplexed into one 64 kbps DS0 channel.
DS0	Digital Signal, level zero. A 64 kbps signal. It is equal to one voice conversation digitized under pulse code modulation.

DS1	Digital Signal, level one. A 1.544 Mbps digital signal carried on a T1 transmission facility.
DSP	Digital Signal Processor.
DSU	Data Service Unit.
DSX-1	Digital Signal Cross-connect Level 1. A set of standard electrical parameters for cross-connecting DS1 lines.
DSX	Digital System Cross-connect frame. A bay or panel to which T1 lines and DS1 circuit packs are wired and that permits cross-connections by patch cords and plugs.
DTMF	Dual Tone Multi-Frequency.
E & M	Ear and Mouth.
ERL	Echo Return Loss.
ESF	Extended Super Frame. A T1 format that uses the 193rd bit as a framing bit. ESF provides frame synchronization, cyclic redundancy checking and data link bits.
FXO	Foreign Exchange Office.
FXS	Foreign Exchange Subscriber.
GS	Ground Start.
I/O	Input / Output.
IRE	An IRE is 1/100 part of the luminance (blanking to reference white) range. The zero IRE shall be at the blanking level and 100 IRE at reference white level. IRE below blanking level shall be referred to as negative values.
ISDN	Integrated Services Digital Network.
LBO	Electrical Line Build Out.
LGS	Loop Ground Start.
LS	Loop Start.
OCU	Office Channel Unit.
NTSC	National Television Systems Committee.
PCM	Pulse Code Modulation.
PLAR	Private line, Automatic Ringdown.
PLR	Pulse Link Repeater.
ppm	periodic pulse metering.
QRSS	Quasi Random Signal Source.
SRL	Signal Return Loss.
Switched 56	A switched line digital service provided by the Private Telephone Network. It supports 56,000 bits per second data rate only.
T1	A standard digital transmission link with a capacity of 1.544 Mbps normally handles 24 voice channels at 64 kbps.
TLP	Transmission Level Point.
VF	Voice Frequency.
μ-law	PCM coding and companding standard used in North America.

#### 10-6.02 GENERAL

Communication equipment shall conform to all rules and regulations of the Federal Communications Commission (FCC) and shall conform to the provisions in Section 86, "Signals, Lighting and Electrical Systems," of the Standard Specifications and these special provisions.

The Contractor shall arrange to have a technician, qualified to work on the communication equipment and employed by the communication equipment manufacturer or his representative, present at the time the equipment is turned on.

Prototype equipment is not acceptable. All equipment shall be current standard production units and shall have been in use for a minimum of 6 months. Rebuilt or reconditioned equipment will not be allowed.

All rack mounted equipment and card cage assemblies shall have metal filler plates to cover any unused channel slots or card slots.

### 10-6.03 MODIFY TRANSPORTATION MANAGEMENT CENTER

The modify transportation management center (TMC) assembly shall consist of installing the following equipment into existing racks:

Qty	Description
1	Video Demultiplexer

The Video Demultiplexer is described elsewhere in these special provisions.

### 10-6.04 MODIFY COMMUNICATION HUB ASSEMBLY

The modify communication hub assembly (15/91 IC) shall consist of installing the following equipment into existing racks:

Qty	Description
_1_	Card cage assembly
_1_	TCVR-CH
_1_	Video Multiplexer
_1_	T-1 Multidrop communication system

The AFOM and the RS-232 serial cables are described elsewhere in these special provisions.

#### 10-6.04A CARD CAGE ASSEMBLY

Card cage assembly shall have capacity for 15-25.4mm wide cards. Overall dimensions for the card cage assembly shall be 133mm H x 482.6mm W x 254mm D made from an aluminum chassis, and having an unloaded weight of under 2.268g. Operating temperature shall have a range of -20° C to 50°C. Card cage assembly shall have a power supply for the modems and TCVRs with line cord with input power range of 115 VAC  $\pm$  15%, 60 Hz. The interface cable between the asynchronous fiber optic modems and TCVR-CHs in the card cage assembly and the RS-232 distribution panel shall be specified by the RS-232 distribution panel manufacturer and provided and installed by the Contractor.

#### 10-6.04B CAMERA TRANSCEIVER IN COMMUNICATIONS HUB(TCVR-CH)

TCVR-CH shall be located in the communication hub structures shall conform to the requirements of TCVRs specified for CCTV camera assemblies with the following differences:

The TCVR-CH shall transmit RS 232 data for the auxiliary control unit (ACU) at each camera site and shall receive NTSC video from the CCTV camera assembly.

The TCVR-CH video receiving and data transmitting format used in the communications hub shall be compatible with the TCVR video transmission and data receiving format used by the TCVRs at each of the camera junction boxes.

The TCVR-CH shall be packaged as one rack unit (1 RU x 482.6mm) insertable module or shall be individual rack modules such as a receiver, transmitter and wavelength division multiplexer to combine both data and video onto one optical fiber.

The TCVR-CH shall be mounted in one rack unit (1 RU x 482.6mm) insertable, and have the operating temperature range between 0° C. to +40° C. (minimum.)

#### 10-6.04C VIDEO MULTIPLEXER

The video multiplexer used under this contract and the video demultiplexer system components will be from the same manufacturer and shall be fully compatible and interoperable with the existing International Fiber Systems (IFS) model AWS 3000.

The multiplexer shall be expandable to be capable of providing transmission (multiplexing) of up to a minimum of 16 channels(only 1 channel used on this project) of baseband video (RS-170A) via an FM modulated multiplexer from the communication hub to the Transportation Management Center. All equipment shall have the operating temperature range between 0° C. and 50° C.

The video multiplexer shall be frequency agile and shall accept any NTSC baseband video signal and convert it to a modulated electrical signal suitable for mixing with other signals to produce a composite broadband signal to the optical transmitter input. The multiplexer output frequency range shall be between 40 to 550 MHz (minimum range).

**INSTALLATION.**--The video multiplexer system units shall be installed at the Communication Hub as identified on plans. The Contractor shall connect the correct optical pigtail or patch cord to the optical connector on the transmitters, as well as the correct video interface cables to the multiplexer inputs and multiplexer outputs as specified by the equipment manufacturer. The Contractor shall coordinate the physical space required by the video multiplexer with the space allocated for any other equipment. The Contractor shall connect the video multiplexer power supply to one of the 120 VAC, 60 Hz power receptacles reserved for communications equipment in the communication hub. The fiber optic path for each video link shall be tested and verified in accordance with the contract prior to installing the video multiplexer. The Contractor shall neatly install all drop cables together, route them along the same path and shall neatly secure them to the support rails in the equipment racks. No cables shall be installed with a bend radius less than the manufacturer's minimum recommended bending radius.

#### **10-6.04D VIDEO DEMULTIPLEXER**

The video demultiplexer used under this contract and the video multiplexer system components will be from the same manufacturer and shall be fully compatible and interoperable with the existing International Fiber Systems (IFS) model AWS 3000.

The system shall be expandable to be capable of providing transmission (multiplexing) of up to a minimum of 16 channels (only 1 channel used on this project) of baseband video (RS-170A) via an FM modulated multiplexer from the communication hub to the demultiplexer in the Transportation Management Center. All equipment shall have the operating temperature range between 0° C. and 50° C.

The video demultiplexer shall be frequency agile and shall accept any NTSC baseband video signal and convert it to a modulated electrical signal suitable for mixing with other signals to produce a composite broadband signal to the optical transmitter input. The demultiplexer output frequency range shall be between 40 to 550 MHz (minimum range).

**INSTALLATION.**--The video demultiplexer system units shall be installed in the Transportation Management Center as identified on plans. The Contractor shall connect the correct optical pigtail or patch cord to the optical connector on the receivers, as well as the correct video interface cables to the demultiplexer inputs and demultiplexer outputs as specified by the equipment manufacturer. The Contractor shall coordinate the physical space required by the video demultiplexer with the space allocated for any other equipment. The Contractor shall connect the video demultiplexer power supply to one of the 120 VAC, 60 Hz power receptacles reserved for communications equipment in the Transportation Management Center. The fiber optic path for each video link shall be tested and verified in accordance with the contract prior to installing the video demultiplexer. The Contractor shall neatly install all drop cables together, route them along the same path and shall neatly secure them to the support rails in the equipment racks. No cables shall be installed with a bend radius less than the manufacturer's minimum recommended bending radius.

#### **10-6.05 T-1 MULTIDROP COMMUNICATION SYSTEM**

There exists presently at the communications hub a Newbridge Networks Model 3600 Mainstreet Bandwidth Manager. This T1/DS1 multiplexer provides equipment communications between Hub and the TMC via a standard T1 bandwidth of 1.544 Mbps interface. T1 Multidrop Communication System shall consist of installing the following equipment into the existing T1/DS1 multiplexer system at the communications hub at the 15/91 interchange:

Qty	Description
1	State furnished T1/DS1 multiplexer shelf and equipment
1	State furnished RS 232 distribution panels
2	Asynchronous fiber optic modems
1	DS1 optical modems
4	RS232 serial cables

The state furnished T1/DS1 multiplexer shelf and equipment consist of the following equipment:

Qty	Description	Newbridge Part No.
1	T-1 shelf	90-0010-10
1	AC power shelf	90-0435-02
1	AC power shelf upgrade kit	90-0481-02
1	T1 dual card	90-0564-01
2	T1 LIM module	90-0567-01
1	GFC	90-0078-04
1	RS232 sync/asyme	90-0043-03
1	DSP-3	90-0038-09

The contractor shall supply and install:

- Dual shelf cable assembly(Part No. 90-0090-05)

Note: for the TOS CABINET ASSEMBLY installation on this project the following specifications apply for the T-1 MULTIDROP COMMUNICATION SYSTEM:

Also included shall be the associated power supplies and interconnect cables which shall provide T1 multiplexing and switching functions for multi-location interfacing to standard DS1 signals and remote data using RS 232 and voice communication systems as described elsewhere in these special provisions. The T1 multidrop communication system equipment shall transmit and receive RS 232 information via optical fiber and shall provide for the ability to multidrop asynchronous RS 232 information.

Local operator control of all essential features of the T1/DS1 multiplexer equipment shall be accomplished by the use of necessary discrete front panel controls. Dual V.24/RS 232 ports for local operator control and remote Network Management System functions and/or Control/Status reporting shall be provided.

The operation of the T1/DS1 multiplexer shall not produce any electrical noise which will interfere with the operation of any other equipment when proper cables are used.

All printed circuit boards shall be of epoxy glass based material or other high quality material. All common equipment and channel unit boards shall be made to conform coating for added protection against moisture, salt, and other environmental agents.

The T1 multidrop communication system equipment shall be designed with all the circuitry mounted on plug-in cards or modules in a single equipment shelf (that shall have no active components on its backplane). Modular design is required to allow a user to configure the multiplexer equipment for specific needs by plugging in the appropriate modules and to allow field repairs to be accomplished using plug-in module replacements. The multiplexer equipment shall be expandable in increments, channel by channel, until shelf capacity is reached.

The T1 multidrop communication system equipment shall be designed for testing, monitoring, and adjustment without service interruption. Front access shall be provided for all routine adjustments normally required to be performed by field personnel.

Spare positions--the absence of channel cards from the spare shelf positions, if provided, shall not affect equipment operation nor generate alarm conditions.

#### **10-6.05A DISTRIBUTION PANEL**

The distribution panel shall be a Newbridge Networks' Model 90-0350-01 or equal. Interface connector and cable assembly shall be as specified by the manufacturer to interface between the T1/DS1 multiplexer direct connect cards and the distribution panel. All interface connectors and/or cables between RS 232 distribution panel and T1/DS1 multiplexer shall be provided and installed by the Contractor and as recommended by the manufacturer of the T1/DS1 multiplexer.

The connectors shall be female DB25 connectors and the cable length shall be a minimum of 1 m and not more than 15 m.

#### **10-6.05B RS-232 SERIAL CABLE**

There shall be one RS-232 serial cable per asynchronous fiber optic modem to provide a link between the modems and the RS-232 Distribution Panel. The RS-232 serial cable shall meet the following requirements:

Length: 0.5 meters  
Termination: DB-25p, Bare-wire for screw terminal  
Conductors: Straight through DB-25 to DB-25  
Cable Jacket: Polyethylene

#### 10-6.05C ASYNCHRONOUS FIBER OPTIC MODEM (AFOM)

The asynchronous fiber optic modem shall be used as an RS-232C interface between 170 controller and T1/DS1 multiplexer via optical link. The modem located in the communication hub shall be a rack mounted version installed in the card cage assembly. Model 170 controller interface modems shall be stand-alone units securely fastened on a rack mounted shelf. An LED indicator shall be provided for use in determining received optical power.

The asynchronous fiber optic modem shall be fully compatible and interoperable with the existing International Fiber Systems Inc. models D9230SC (wall mount) and D9230SC-R3 (rack mount).

The modem shall meet the following requirements:

Electrical Signaling	Per EIA RS-232 with full handshake control signals
Electrical Power	VDC version: +9 to +14 VDC @ 32mA, nominal. VAC version: 115 VAC $\pm$ 10%, 60 Hz.
Bit Error Rate	1 in 10 <sup>9</sup> within optical budget.
Operating Mode	Asynchronous, simplex or full duplex.
Input/Output Logic Level	I: +3.75 to +12 V. O: -3.75 to -12 V.
Input/Output Impedance	Per RS-232D
System Bandwidth	DC to 56/64 kbps
Optical Wavelength	1300 nm.
Minimum Optical Receiver Sensitivity	-30 dBm
Minimum Transmit Output Power	-10 dBm
Connectors Optical:	SC
Connectors Electrical (Data)	DB25 female
Number of fibers	2
Mechanical Size	7.00"W x 5.00"D x 1.00"H for stand-alone module
Weight	6 oz. (170 g) for stand-alone module, nominal
Environmental Ambient:	
Temperature Range	-20 °C. to +70 °C.
Storage Temperature	-40 °C. to +85 °C.

The asynchronous fiber optic modem shall be tested as follows:

Each optical modem shall be functionally tested by looping back the optical transmit connector to the optical receive connector using a variable optical attenuator with measured optical loss of 20 dB, nominal, at 1300 nm. A test set shall be connected to the modem and set for RS-232 communications testing. A fifteen minute test after burn-in shall be error free.

After performing the fifteen minute bit error rate (BER) test, at least two modems shall be tested for receiver dynamic range. To do this the optical attenuation shall be increased to the point at which the data test just begins to register bit errors. The optical receive power into the modem shall be measured and recorded. The optical attenuation shall be then decreased until the data test once again registers errors. At no time shall the optical power into the receiver exceed the manufacturer's specified saturation level. The optical receive



level shall once again be measured and recorded. These minimum and maximum receive levels define the modem receiver's dynamic range.

One pair of modems shall be interconnected using optical patchcords and attenuators with a loss of 20 dB, nominal, in each direction. The RS-232 interface shall be looped back on one modem and a test set connected to the RS-232 interface of the other modem. A bit error rate of less than 1 in  $10^9$  shall be demonstrated.

#### 10-6.05D DS1 OPTICAL MODEM

The DS1 optical modem converts between the electrical signals of the T1/DS1 multiplexer aggregate interface card and the optical signals used on the single mode optical fiber facility. An LED indicator shall be provided for use in determining received optical power. Two modems and the fibers connecting them will form the T-1 transmission facility.

The DS1 optical modem shall be fully compatible and interoperable with the existing International Fiber Systems Inc. model D1230-R3 (rack mount).

The electrical DS1 interface of the optical modem shall comply with the ANSI T1.102-1987 standard and compatible with the T1/DS1 multiplexer.

The optical interface shall be designed for single-mode operation using an optical wavelength of between 1250 and 1350 nm.

The optical launch power of the transmitter shall be at least 15 dB greater than the sensitivity of the receiver. Sensitivity is defined as the minimum optical receive power required to maintain the specified error rate. The saturation level is the maximum optical received power that the receiver can tolerate before the error rate is exceeded.

At no time shall the received optical power exceed the receiver's saturation level. Optical attenuators with a return loss of 15 dB, shall be provided.

A bit error rate of less than or equal to 1 in  $10^9$  shall be certified over the specified operating ranges.

The DS1 optical modem shall be transparent to any zero-code suppression used by the T1/DS1 multiplexer and/or terminal equipment.

The DS1 modem shall be rack-mount version. The rack mount card cage shall be capable of housing a minimum of 15 modems in no more than 150 mm of vertical rack space. The modems shall have the same mechanical size as the asynchronous fiber optic modem.

All hardware necessary for mounting the modem in a standard 482 mm rack shall be provided.

The DS1 cables shall be routed between the T1/DS1 multiplexer and the optical modems.

The DS1 cables shall be connectorized as appropriate and specified by the T1/DS1 multiplexer manufacturer.

The output power of each modem shall be externally attenuated to be compatible with the optical loss of the fiber being used. The optical receive power at each modem shall be measured and recorded before connection of the receive optical patchcord or pigtail. The optical patch cords or pigtails shall be attached as required.

The DS1 optical modem shall meet the following requirements:

Electrical Power:	Rack mount version: +12 to 18 VDC @ 115 mA per module or 12 to 16 VAC at 2W.
Bit Error Rate:	1 in $10^9$ within optical budget
System Bandwidth:	DC to 2.048 Mbps
Optical Wavelength:	1300 nm, nominal
Connectors Optical:	Type SC
Connectors Electrical (Data):	The physical interface shall be either a female 15 pin D-type connector or a 8-position screw terminal with cable shield
Environmental Ambient Temperature Range:	-20°C to +50°C
Storage Temperature:	-40°C to +85°C

Patchcords and pigtails shall be tested as follows:

Each optical modem shall be functionally tested by looping back the optical transmit connector to the optical receive connector using a variable optical attenuator with measured optical losses of 10 dB at 1300 nm. A DS-1 test set shall be connected to the modem and set for ESF framing, B8ZS coding, internal timing, and a QRSS pattern. The test set shall also be set for the standard AMI framing, DSX-1 output level and terminated input. A fifteen minute test after burn-in shall be error free.

After performing the fifteen minute bit error rate (BER) test, at least two modems shall be tested for receiver dynamic range. To do this the optical attenuation shall be increased to the point at which the data test just begins to register bit errors. The optical receive power into the modem shall be measured and recorded. The optical attenuation shall be then decreased until the data test once again registers errors. At no time shall the optical power into the receiver exceed the manufacturer's specified saturation level. The optical receive level shall once again be measured and recorded. These minimum and maximum receive levels define the modem receiver's dynamic range.

One pair of modems shall be interconnected using optical patchcords and attenuators with a loss of 10 dB in each direction. The DS-1 interface shall be looped back on one modem and a DS-1 test set connected to the DS-1 interface of the other modem. A bit error rate of less than 1 in  $10^9$  shall be demonstrated.

#### **10-6.05E T1/DS1 MULTIPLEXER**

The T1/DS1 multiplexer shall replicate the T1 multiplexing, switching and diagnostic functions and features of the Newbridge Networks' Model 3600 Mainstreet Bandwidth Manager or equal. The T1/DS1 multiplexer shall provide equipment communications via a standard T1 bandwidth of 1.544 Mbps interface. The T1/DS1 multiplexer shall support voice, RS 232, V.35, RS-449/X.21/RS-422, X.27, V.11, V.24, V.28 communications with standard data rates of 1.2 kbps to 2.048 Mbps. Remote data on RS 232 field interconnections to the T1/DS1 multiplexer shall be provided through the RS 232 Distribution Panels and the asynchronous fiber optic modems. The remote TOS cabinet's T1 multiplexer interconnections to the T1/DS1 multiplexer in the communications hub assembly shall be provided through the DS1 optical modem.

The T1/DS1 multiplexer and associated equipment shall meet the following standards:

- FCC part 15, Subpart J, Class A device
- FCC part 68
- AT&T Publication 43202
- AT&T Publication 43801
- AT&T Publication 54016
- AT&T Publication 62310
- AT&T Publication 62411
- UL Standard 94
- UL Standard 510
- UL Standard 910
- UL Standard 1441
- UL Standard 1581
- UL Standard 1666
- UL Standard 1863

The DS1 signal shall meet the following minimum electrical requirements:

1.544 Mbps $\pm$ 200 bps line rate with stratum 4 clock
ESF and D4 Mode 3 format
24 DS0 at 64 kbps framing with 8 kbps overhead
B7, B8ZS, or AMI line coding
B8ZS clear channel
100 $\pm$ 10      balanced impedance

T1/DS1 Multiplexer at the TOS cabinet assembly consists of the following:

Qty	Description
1	T1 equipment shelf
1	Line interface modules (LIM) T1
1	Aggregate Cards: Single 1.544 Mbps T1/DS1
2	Data Cards: Direct connect cards
1	Resource Cards: DSP-3 Cards
1	Common Control Cards: System Control Card 3
1	Common Control Cards: General facilities card
1	Common Control Cards: Expander card

All equipment listed is rack mounted and described below or elsewhere in these special provisions. Also included in the TOS cabinet assembly will be the installation of the Model 334 cabinet foundation.

The Model 334 cabinet, without anchor bolts, will be State-furnished as provided under "Materials" of these special provisions.

The Contractor shall construct each cabinet foundation as shown on Standard Plan ES-3C for Model 334 cabinets (including furnishing and installing anchor bolts) and shall install the cabinet on said foundation. The Contractor shall make all field wiring connections to the cabinet for the power conductors and all related fiber optic connections as shown on the plans.

The T1/DS1 multiplexer shall meet the following requirements:

Operating temperature range: 0° to +50° C ambient.

Operating humidity range: 95 percent relative (non-condensing).

**Front panels.**--Channel units and common equipment shall be of plug-in design each incorporating locking devices on the front face insuring proper position, without requiring unique tools to perform installation or removal. Each unit shall incorporate a label describing the card type.

**Mounting.**--All equipment shall provide for a minimum of four mounting screws in order to flush mount the equipment in a standard 482 mm EIA-310 rack space, unless otherwise specified elsewhere in these specifications.

**Function.**--The T1/DS1 multiplexer equipment shall provide the functions of digital cross-connect, drop and insert, channel bank, fractional T1, ISDN and integrated voice and data multiplexer in a combination of single function systems or as a combined system on a non-blocking basis and be software configurable at the DS0 level. There shall be software internal to the T1/DS1 multiplexer for diagnostics, maintenance, setup and operations.

The T1/DS1 multiplexer shall have the capability for multiplexing and demultiplexing a minimum of two DS1 signals. A secondary DS1 line shall be used for redundancy or when additional site growth is required. The multiplexer shall drop, insert and bypass multiplexing at the DS0 and/or Subrated DS0 circuit level and shall be software configurable via the Network Management System.

The bypass requirements of the T1/DS1 multiplexer shall be programmed to automatically switch to a T1 bypass mode upon sensing any major common equipment unit failure affecting frame synchronization, local clocking or unit power.

The T1/DS1 multiplexer equipment shall incorporate a drop and insert feature which provides access to a minimum of 24 DS0 ports without installation of back-to-back fully sized bank. Single and dual direction drop and insert operation shall be provided and mount in a single shelf unit. Channel units and major common equipment items shall be identical with those utilized at fully equipped terminal locations. Equipment shall be configurable to operate either as single or dual direction true drop and insert as well as bridging drop and insert allowing bridging/distribution equipment items. Drop and insert equipment shall, regardless of configuration (single, dual or bridging), allow field selection of desired channel utilization. Drop and insert channel selection shall be accomplished via software input on common control cards, as specified elsewhere in the special provisions, or via a network management system software package.

Digital cross connect switching of user data shall be from one card slot to another at the DS0 level. The switching of circuits within the matrix shall be accomplished locally via a node management terminal interface which shall access software internal to the T1/DS1 multiplexer via a dumb terminal (VT-100) and/or remotely via the network operator (network management system.). Channel bank operation shall be protocol transparent.

The T1/DS1 multiplexer shall provide for a minimum of 24 channels of full duplex RS 232 information to be transmitted via several DS0s or within one DS0.

The T1/DS1 multiplexer shall fully support and perform channel bypass of either single DS0's, or multiple DS0's, and the switching of DS1 trunks. The multiplexer shall have the ability to switch data and voice at a DS0/DS1 level from a combination of methods such as: I/O to Network Trunk, I/O to Inter-nodal Trunk, I/O to I/O, Network Trunk to Network Trunk and Inter-nodal Trunk to Inter-nodal Trunk. Additionally, the multiplexer shall have the ability to perform subrate merging/multiplexing, and route a subrate channel to any Inter-nodal trunk resident at the Node. The multiplexer shall be capable of performing subrate switching in order to route a subrate channel to any other time slot at any node in the system. The multiplexer shall be capable of performing non-blocking switching of any DS0 time-slot from any system bus on to any DS0 time-slot belonging to any other system bus.

The T1/DS1 multiplexer shall fully support asynchronous point to point data circuits between any two locations on the network. Asynchronous transmission speeds ranging from 1200 bps to 19.2 kbps in full duplex mode shall be supported. Standard asynchronous signaling shall consist of 1 start signaling element, 5 to 8 data signaling elements, up to one parity bit, and 1, 1 1/2 or 2 stop signaling elements shall be transmitted and received by the system as user data. The multiplexer shall support multi-point asynchronous data circuits between the master and multiple slaves (minimum of 10) with the multipoint data being dropped off at the same DS0 and subrate channel within that DS0.

The T1/DS1 multiplexer shall fully support synchronous point to point and multi point data circuits between any two locations on the network. Synchronous data circuits shall be able to transmit bit oriented user data and its associated clocking information to any location on the network at speeds from 1200 bps to 1.544 Mbps. At the remote end of the synchronous point to point or multi point circuit, identical bit oriented user data shall be provided, as well as the reconstructed clock whose frequency is identical to the currently connected transmitter clock. A synchronous connection shall not require that other synchronous circuits be synchronized relative to one another.

The T1/DS1 multiplexer shall be able to multiplex multiple rate adapted subrate (i.e., 64 kbps) data circuits onto a single 64 kbps DS0 channel on the T1 multidrop communication system across any nodes. The multiplexer shall be able to digitally bridge (within the T1 multiplexer) multiple (i.e., DS0's) multidrop slave circuits to a single multidrop master.

The TOS cabinet assembly equipment (RS 232 type devices) shall be connected with the T1/DS1 multiplexer via RS 232 extender modules. Extenders shall provide multiplexer/remote equipment interconnection for distances up to 5 kilometers from the multiplexer node. Communications with the node shall be via a 2 wire 2 B+D or 2 wire 2B1Q type interface. Each extender shall support two 64 kbps bearer channels and shall provide extension of RS 232 communications as well as network management system diagnostics and reporting. The extender shall be capable of varying speeds up to 64 kbps and shall be done remotely through network management system.

**T1 EQUIPMENT SHELF.**--The T1 equipment shelf shall accommodate all universal channel slot, common control, resource, and extender cards as described under these special provisions to configure the T1/DS1 multiplexer. The T1 equipment shelf shall be compliant with Federal Communications Commission (FCC) Class A - Type II requirements. Cable entrances shall be located at the top and bottom of the back panel. An equipment interface area shall be provided with connectors to connect to external equipment such as the RS 232 distribution panels, as described elsewhere in these special provisions. A single shelf shall be composed of 12 card slots and divided into the universal channel slot (UCS) card section and the common control card section. Eight slots shall be designated for the UCS card section and 4 slots for the common control card section. The power section shall be configured with dual redundant load sharing 120 VAC power supplies that meet the following requirements:

Operating AC power supply voltage range from: 102 V to 132 V.

Each T1/DS1 multiplexer shall have the provision to be configured with a dual internal redundant load sharing -48 VDC power supplies. In the event of a commercial AC power failure the T1 multiplexer shall be capable of uninterrupted operation by deriving -48 VDC power from a backup battery source. (Battery source not required under this contract.) The T1/DS1 multiplexer shall be convection cooled when powered by -48 VDC. No forced-air cooling devices shall be permitted.

All power and ground connectors shall be screw-terminal or UL-approved connectors. Wire-wrap post, and solder post terminals are not acceptable.

Required channel card supply voltage and current levels shall be provided by terminal common equipment being distributed on the shelf backplane.

The T1 equipment shelf shall have a nominal size of 482 mm (W) x 254 mm (D) x 482 mm (H).

**Backplane requirements.**--The T1/DS1 multiplexer shall be designed with shelf motherboard (backplane) connecting the channel cards and common equipment together. Specifically a wire-wrap or bundled wiring harness construction shall not be permitted.

The backplane shall be designed to support a mixture of voice and high speed data.

**Crosstalk.**--The T1/DS1 multiplexer shall be designed to allow physical separation of voice and data traffic to different connectors on the backplane. High speed data lines shall not be permitted to produce crosstalk on adjacent high speed data lines.

Ring voltage on voice lines are not permitted to produce crosstalk on adjacent high speed data lines.

**LINE INTERFACE MODULE (LIM) T1:** The T1/DS1 multiplexer shall fully support an integrated LIM T1 module. The LIM shall be modular to the T1/DS1 dual and single 1.544 Mbps aggregate cards. The LIM shall support the DSX-1 electrical interface and loopbacks towards the T1 line, and shall be software controllable through the T1/DS1 multiplexer. No external buttons, switches and dip switches shall be used or allowed to activate loopbacks. The integrated LIM shall meet the specifications in AT&T Compatibility Bulletin #119 Interconnection Specification for Digital Cross-Connects. The integrated LIM shall be locally powered. Span simplex power can be either looped in channel bank mode or passed through in drop and insert mode.

Network specifications:

Line Rate:	1.544 Mbps $\pm$ 32 ppm
Line Code:	AMI and B8ZS
Frame Code:	D4 and ESF
Output Signal:	$\pm$ 3.0 V peak to peak nominal
Impedance:	100
Input Signal:	$\pm$ 3.0 V peak to peak nominal
Sensitivity below DSX-1:	-10 dB (0 dB = 2.4 V peak to peak)
Pre-Equalization Ranges:	0 to 45 m 46 m to 137 m 138 m to 198 m

Pulse Density specifications:

Zero suppression (software controllable):	AT&T Publications 62411
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Connector specifications:

Connector Type:	25-pair Amp Champ Connector on the backplane
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**ESF Facility Data Link (FDL).**--The FDL shall meet AT&T TR publication 54016, SPRINT TS-0031, and SPRINT TS-0025. The FDL shall decode the CRC-6 error algorithms, maintain error statistic counters, and make such statistics available to the network technician. FDL reports shall include, at a minimum, current ESF error event counter report, one hour performance report and twenty-four hour performance report.

**DS0 map assignments.**--The T1/DS1 multiplexer shall have at least eight internal maps to store different DS0 assignments of the channel cards. New DS0 assignments may be made in an "off-line" manner and shall not affect traffic until all the new DS0 assignments have been completed and a change of map command issued. New DS0 assignment shall be made through Simple Network Management Protocol (SNMP) or Control Packet Switching System (CPSS) protocol. Contractor shall provide the Engineer the protocol packet technical specification. DS0 maps shall be capable of handling any 24 DS0 combinations in both T1 spans simultaneously and all physical channel card slots in the channel bank. Two configured matrix maps from each T1 to T1 span shall be active simultaneously. Any physical channel card slot shall be assignable to any multiple of DS0 time slot in either T1 line.

**Clock source.**--the primary clock source shall be software selectable from an internal master clock, an external master clock, or from the T1 span. If the internal source fails the programmed alternate source shall be selected automatically. The T1/DS1 multiplexer shall accept an external master clock that provides a clock frequency from 8 KHz to 1.544 MHz in any multiple of 1600 Hz.

**UNIVERSAL CHANNEL SLOT CARDS.**--The T1/DS1 multiplexer equipment shall support the following channel cards:

**Aggregate Cards:**

**Dual and single 1.544 Mbps T1/DS1 Cards.**--Dual and single 1.544 Mbps T1/DS1 aggregate cards shall be remotely and locally configurable via the control port, meet the DS1 electrical signal requirements and AT&T publications as specified elsewhere.

**Fixed 56/64 kbps cards.**--Fixed 56/64 kbps cards shall be remotely and locally configurable via a control port and meet the following requirements:

Synchronous

Interface types: (1) V.35, V.24/RS 232, V.36 and V.37 and (2) X.21/V.11

Modes: (1) bi-directional - transmit on the primary or the secondary T1, (2) Point to point and (3) polled - shared time slots CGA alarm capable.

**56/64 x n kbps cards.**--The 56/64 x n kbps cards shall be remotely and locally configurable via the control port and meet the following requirements:

Synchronous

Interface types: (1) V.35, V.24/RS 232, V.36 and V.37 and (2) X.21/V.11

Modes: (1) bi-directional transmit on the primary or the secondary T1, (2) Point to point and (3) polled - shared time slots CGA alarm capable.

**Data Cards:**

**Direct Connect Cards.**--Direct connect cards shall be remotely and locally configurable via the control port and meet the following requirements:

Synchronous or Asynchronous

Interface type: V.24/RS 232

Date rates: from 150 bps to 64 kbps.

6 or more RS 232 channels per card capacity with DB-25 female connectors.

Capable of supporting a real time polling system for network management utilizing Simple Network Management Protocol (SNMP) and/or Control Packet Switching System (CPSS).

**Subrate Multiplexer Cards.**--Subrate data multiplexer cards shall be remotely and locally configurable via the control port and meet the following requirements:

Synchronous or Asynchronous

Interface types and data rates shall support: (1) X.21 - 50 bps to 19.2 kbps (2) V.35 - 2.4 to 19.2 kbps (3)

V.24/RS 232 - 50 bps to 64 kbps

DS0-A and DS0-B DDS compatible

6 or more DS0-A or DS0-B channel per card capacity

Capable of supporting a real time polling system for network management utilizing Simple Network Management Protocol (SNMP) and/or Control Packet Switching System (CPSS).

**Voice Cards:**

**E&M 4-wire voice cards.**--The E&M 4-wire voice cards shall be remotely and locally configurable via the control port and meet the following requirements:

Nominal transmission levels (dBm):

Transmit: -16.0 to +7.0

Receive: -16.0 to +7.0

Frequency response from 300 to 3000 Hz:

Transmit: +0.15 to -0.15 dB

Receive: +0.15 to -0.15 dB

4-Wire impedance: 600

Return loss from 300 to 3000 Hz: 23 dB

Signaling modes: standard E&M, E&M tandem loop start, and E&M tandem ground start.

Signaling types: E&M types I, II, III, and PLR types I, II.

Transmission direction: shall be selectable to either the primary or secondary T1.

VF cards shall be able to be taken out of service without dropping all other active circuits.

VF cards shall visually indicate on front panel their active, idle and ringing status.

For inventory control purposes, all cards shall report via software their serial number and revision level.

**FXS 2-Wire voice cards.**--The FXS 2-Wire voice cards shall be remotely and locally configurable via the control port and meet the following requirements:

Nominal transmission levels (dBm):

Transmit: - 12.0 to + 0.0

Receive: - 10.0 to + 6.0

Frequency response from 300 to 3000 Hz:

Transmit: -0.25 to +0.5 dB

Receive: -0.25 to +0.5 dB

2-Wire impedance either 600 or 900 with return loss:

ERL > 34 dB, minimum

SRL > 20 dB, minimum

Signaling modes to be supported: FXS, LS, GS and PLAR.

PCM  $\mu$ -law voice signaling and companding conversion standards shall be supported.

Signaling types shall be loop start and ground start.

Transmission direction shall be software selected from either the primary or secondary T1.

**FX0 2-Wire voice cards.**--The FX0 2-Wire voice cards shall be remotely and locally configurable via the control port and meet the following requirements:

Nominal transmission levels (dBm):

Transmit: -12.0 to + 0.0

Receive: +10.0 to + 6.0

Frequency response from 300 to 3000 Hz:

Transmit: -0.25 to +0.5 dB

Receive: -0.25 to +0.5 dB

2-Wire impedance either 600 or 900 with return loss:

ERL > 28 dB, minimum

SRL > 20 dB, minimum

Signaling modes to be supported: FX0, LS and GS

PCM  $\mu$ -law voice signaling companding conversion standards shall be supported.

Signaling types shall be loop start and ground start.

Transmission direction shall be software selected from either the primary or secondary T1.

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**Order wire voice cards.**--The Order wire voice cards shall be remotely and locally configurable via the control port and meet the following requirements:

Nominal transmission levels (dBm):

Transmit: - 12.0 to +0.0

Receive: - 10.0 to +6.0

Frequency response from 300 to 3000 Hz:

Transmit: -0.25 to +0.5 dB

Receive: -0.25 to +0.5 dB

2-Wire impedance either 600 or 900 with return loss:

ERL > 28 dB, minimum

SRL > 20 dB, minimum

Signaling modes to be supported: LS, GS and PLAR.

Individual DTMF addressing from any other order wire card.

Operating modes to be supported: loop ground start operation, voice activated transmission, and tone and pulse dialing.

#### **Telco Cards:**

**Office Channel Unit Data Port.**--The office channel unit data port (OCUDP) shall be remotely and locally configurable via the control port and meet the following requirements:

4-wire baseband digital interface

Switched 56 and DDS services shall be supported

Bi-directional transmit to either the primary or secondary T1

56 kbps or 64 kbps transmission

Switched 56 or DDS compatible with or without secondary channel (Type I)

DDS I and DDS II compatible

Error Correction

Automatic Line Buildout (LBO)

Full two mile span from line drivers.

Automatic Equalization

DDS loopback capability (CSU, DSU and OCU loopbacks)

Sealing current

**Transmit Only 4-Wire Voice Cards.**--The transmit only (TO) 4-wire voice cards shall be remotely and locally configurable via the control port and meet the following requirements:

Nominal transmission levels (dBm):

Transmit: -17.5 to +13.0

Receive: -17.0 to +8.0

Frequency response from 300 to 3000 Hz:

Transmit: +0.15 to -0.15 dB, minimum

Receive: +0.15 to -0.15 dB, minimum

4-Wire impedance either 600 or 900

Return loss from 300 to 3000 Hz:  $\geq 23$  dB

Transmission only without robbed bit signaling

Transmission direction shall be selected from either the primary or secondary T1.

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VF cards shall be capable of being taken out of service without dropping active customers.  
VF cards shall visually indicate on the front panel their active or idle state.  
For inventory control purposes all cards shall report via software their serial number and revision level.

#### **Resource Cards:**

**Frame Relay Switch Card.**--Frame relay switch card shall be capable of being remotely or locally configured via the control port and provide frame routing, dynamic bandwidth allocation, congestion control and frame error checking.

**Digital Signal Processor (DSP) Cards.**--Digital signal processor (DSP) cards shall be capable of being remotely or locally configured via the control port and meet the following type requirements:

**DSP-1 Card.**--The DSP-1 card shall support 26 DS0 channels and provide subrate multiplexing and multidrop data bridging applications.

**DSP-2 Card.**--The DSP-2 card shall support 26 DS0 channels and provide subrate multiplexing, multidrop data bridging, PCM bridging, and DDS applications.

**DSP-3 Card.**--The DSP-3 card shall support 48 DS0 channels and provide subrate multiplexing, multidrop data bridging, PCM bridging, DDS and High Capacity Voice applications.

**DSP-4 Card.**--The DSP-4 card shall support 48 DS0 channels and provide subrate multiplexing, switching, multidrop data bridging, PCM bridging, DDS and High Capacity Voice applications.

**Data Communications (DCP) Card.**--Data communications (DCP) card shall be capable of being remotely and locally configured via the control port and meet the following requirements:

31 Control packet switching system (CPSS) channels per card capacity  
High speed and high capacity CPSS packet switching  
DDS and ADPCM compatible

#### **Common Control Cards:**

**System Control Card 3.**--The system control card 3 shall be capable of being remotely and locally configurable via the control port and meet the following requirements:

Have integral memory module with the latest software version.  
Contain built-in test circuitry which detects a failure or fault condition and supplies a fault indication.  
Node system processing, maintenance and timing generation.  
Digital cross connect switching (DCS).  
Communications from internal memory module using non-volatile memory to resource cards, application cards, channel units and data termination units/panels.  
Alarm monitoring and notification  
Display T1/DS1 Multiplexer status  
Two RS 232 serial ports

**General Facilities Card.**--The general facilities card shall be capable of being remotely and locally configurable via the control port and meet the following requirements:

μ-law faceplate as per AT&T specifications  
Alarm port  
Voltage testpoints for T1/DS1 Multiplexer and channel card power supplies  
Network testpoints: 600 Ohm terminating impedance at 0 dB TLPs  
Tone generator as per CCITT G.711 standard  
Timing input for T1 and composite 64 KHz signals  
Order wire configurable as a LGS circuit with either a passive communications link or an audio monitoring channel.

**Expander Card.**--The expander module shall provide additional digital cross connect switching matrix resources to the universal channel slot cards by doubling the bandwidth of the cards by up to 64 Mbps.

**Universal Channel Slot and Circuit Board Extender Card.**--The universal channel slot and circuit board extender card shall meet the following requirements:

The circuit board extender shall extend a circuit board to permit full access to the circuit for testing and maintenance.

A circuit board placed into the circuit board extender shall be fully functional.

Circuit board extender cards shall be provided to permit "extending" any one circuit board at a time.

Each channel slot of the multiplexer shall meet all performance requirements specified herein while any circuit board extender is installed.

#### 10-6.06 TRAFFIC OPERATION SYSTEM (TOS) CABINET ASSEMBLY

The TOS cabinet assembly consists of the following:

Qty	Description
_8_	Asynchronous fiber optic modems
_1_	DS1 optical modem
_2_	RS-232 distribution panels
12	RS-232 serial cables
_1_	T1/DS1 multiplexer
_1_	Interconnect and termination unit
_1_	Card cage assembly

All equipment listed is rack mounted and described below or elsewhere in these special provisions. Also included in the TOS cabinet assembly will be the installation of the Model 334 cabinet foundation.

The Model 334 cabinet, without anchor bolts, will be State-furnished as provided under "Materials" of these special provisions.

#### 10-6.07 MODEL 170 CONTROLLER INTERFACE

The Model 170 controller interface shall consist of an asynchronous fiber optic modem, an interface cable, and an interconnect and termination unit located in the Model 170 controller cabinet. The asynchronous fiber optic modem is described elsewhere in these special provisions.

**INTERFACE CABLE.**-- Interface cable shall consist of six No. 22, stranded tinned copper conductors. Each conductor shall be insulated with 250 µm, minimum nominal thickness, color coded polypropylene material. Conductors shall be in twisted pairs. Each pair shall be wrapped with an aluminum polyester shield and shall have a No. 22 or larger, stranded, tinned copper drain wire inside the shielded pair.

The cable jacket shall be polyvinyl chloride, rated for a minimum of 300 V and 60°C, and shall have a minimum nominal wall thickness of 1 mm. The cable shall be 1 m long with an connector for termination to the Model 170 controller and a DB-25 connector to the asynchronous fiber optic modem. The connector at the Model 170 controller shall meet the following requirements:

Amphenol or equivalent	
Part	Number
Shield	201378-2
Block	201298-1
Guide Pin	200390-4
Socket	200389-4

The cable has the following pin configuration:

Asynchronous F/O Modem	Model 170 Controller	
Function	Pin No.	Function
Ground	N	DC Ground
Carrier Detect	H	DCD
Data Out	L	Rx Data
Data In	K	Tx Data
Ready To Send	J	RTS
Clear To Send	M	CTS
	D	+5VDC

Pin H shall be looped back to pin D and Pin J shall be looped back to pin M.

**INTERCONNECT AND TERMINATION UNIT.**-- Interconnect and termination unit (ITU) shall be packaged in a 482mm rack mount unit with dimensions of 432 mm (W) x 44 mm (H) x 280 mm (D) having metal housing slide-out shelf. The ITU shall contain grommets at cable entrances and provide strain relief for the fiber optic cable. The ITU shall accommodate either 12 or 48 singlemode fibers having SC type connector feed through adapters and either 12 or 48 interconnection points or splices. The components of the passive interconnect package shall be installed in the ITU.

#### 10-6.08 PAYMENT

The contract lump sum price paid for modify transportation management center shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in modify transportation management center, complete in place, including all ancillary or incidental items required to provide full equipment operation at each site, as shown on plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract lump sum price paid for modify communication hub assembly shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in modifying communication hub assembly, complete in place, including all ancillary or incidental items required to provide full equipment operation at each site, as shown on plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract lump sum price paid for traffic operation system cabinet assembly shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing state furnished traffic operation system cabinet assembly, complete in place, including all ancillary or incidental items required to provide full equipment operation at each site, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for furnishing and installing the Model 170 controller interface be considered as included in the lump sum price paid for modify ramp metering system or vehicle detection station and no separate payment will be made therefore.

### SECTION 10-7. SYSTEM TESTING AND DOCUMENTATION

#### 10-7.01 DESCRIPTION

The system testing and documentation shall cover pre-installation testing, physical inspection, subsystem testing, fiber optic cable testing, data link testing, acceptance testing, functional testing, performance testing, final acceptance and system documentation that is required to validate the operational performance of the vehicle detection system, closed circuit television, communication system and ramp metering system, as shown on the plans and described elsewhere in these special provisions.

#### 10-7.02 PRE-INSTALLATION TESTING

Pre-inspection testing shall include testing of all material, equipment and cable in a laboratory environment prior to delivery to the site. Use of laboratory facilities, including an environmental simulation chamber, shall be arranged by the Contractor. The tests shall either be conducted at the equipment manufacturer's premises or at a laboratory arranged by the Contractor.

All material, except test equipment and special tools, shall be bench tested in accordance with the following paragraphs, which include those items described elsewhere requiring pre-installation testing.

All active equipment shall be connected to normal operating power, energized and subjected to normal operating conditions for a continuous period of time in the laboratory of not less than 48 hours.

Functional testing shall be performed by the manufacturer on all material prior to delivery to the site. The functional tests shall be performed in accordance with an approved test plan. Any material or equipment which fails to meet the requirements of the contract shall be repaired or replaced and the test shall be repeated until satisfactory. All functional test results, including results of failed tests or re-tests, shall be submitted and delivered with all material and equipment delivered to the site.

Full performance test shall be performed by the manufacturer or by the Contractor on not less than 5 percent or at least one unit of material selected at random from the normal production run. The full performance test shall be performed in accordance with test plan developed by the Contractor and approved by the Engineer.

### **10-7.03 PHYSICAL INSPECTION**

The Contractor shall provide documentation to prove delivery of all material, equipment, cable and documentation. If any material or documentation is outstanding or have been replaced under pre-acceptance warranty a physical inspection and documentation shall be provided for this material. The physical inspection shall consist of inspecting all installed material to ensure workmanship satisfies the specified requirements.

### **10-7.04 ACCEPTANCE TESTING**

The acceptance testing includes the preparation of an acceptance test plan, conducting acceptance tests and subsequent retests, and documentation of the results.

Final acceptance tests shall be conducted after the site test results have been reviewed and accepted by the Engineer. These tests include the complete system in normal operations. Installation documentation and test results shall be provided for all material, equipment and cable prior to submission of the acceptance test plan and commencement of acceptance tests. This documentation shall be in accordance with the Contract and shall include the following as appropriate:

- Model and part number for all material.
- Test equipment model number, serial number, settings, and date of last calibration.
- All strap and switch settings.
- Record of all adjustments and levels.
- Alignment measurements.
- Identification of interconnections.
- All factory, laboratory and site test results.

The Contractor shall submit three copies of the acceptance test plan to the Engineer for approval prior to commencement of acceptance testing. The acceptance test plan shall address the full testing requirements of the specifications. The acceptance test plan shall detail all tests to be performed, the test results which are expected and the test schedule. The acceptance test plan will include the following major test and acceptance categories:

- Physical inspection
- Functional tests
- Performance tests

The Contractor shall test the communication system according to the approved acceptance test plan and shall provide all test equipment, labor and ancillary items required to perform the testing. The Contractor shall notify the Engineer of his intent to proceed with testing 48 hours prior to commencement of each test.

Tests and inspections shall include:

- Visual inspection for damaged or incorrect installation;
- Adjustments and alignment; and
- Measurement of parameters and operating conditions.

**Fiber Optic Cable Testing.**--Fiber optic cable testing is described in Section 10-4, "Fiber Optic Communication Cable Plant," of these special provisions.

**Video Link Testing.**--The test shall be conducted in accordance with an approved installation and test plan.

Measurements shall be made from the baseband-in to baseband-out connections. A video communications link shall include a TVCR at the CCTV assembly, TVCR at the Communication Hub, interconnecting optical fiber, connectors and power supplies. Video System performance tests for any particular video link shall be performed after the associated camera has been installed and tested.

Each video link in the communications system shall be tested with a video test signal at the video TCVR at CCTV assembly input.

The Contractor shall perform all level adjustments and alignments required on the video link in order for it to operate in accordance with the Contract.

If any video link fails to meet the performance requirements, the Contractor shall take all steps necessary to restore the failed link to the required performance.

Each video link in the communications system shall be tested for qualitative performance with its associated camera turned on and connected to the BNC connector at the camera on top of the pole.

The output video signal in the communication hub shall be connected to a test monitor. The observed picture on the monitor shall be assessed for qualitative performance. All qualitative comments shall be recorded for each camera.

Each video TCVR link shall be tested and recorded for the following performance characteristics. The Contractor shall demonstrate that the performance meets or exceeds the specified requirements.

- Differential Gain
- Differential Phase
- Chrominance to Luminance Delay Inequality
- Amplitude vs. Frequency Characteristic
- Signal to Noise Ratio
- Signal to Periodic Noise Ratio
- Signal to Low Frequency Noise
- Output Signal Level.

The second type of link shall be tested with a video test signal at the video TCVR at the CCTV assembly through the baseband video channel inputs to the video multiplexer unit to the baseband video output channels at the communication hub. All measurements and tests shall be performed as outlined in the first type of link.

**Data Link Testing.**--This section is for the alignment and testing of the data system. The activities shall include verification of all data circuits in the low speed data links, high speed data ring network and in the integrated data system.

The test shall be conducted in accordance to an approved installation and test plan.

The Contractor shall adjust levels required for the data system to operate.

Data link tests shall consist of functional tests conducted between the T-1 multidrop communications system and Model 170 controller interface. The audio channel shall be verified in both directions using telephone instruments. The signaling system shall be verified in both directions.

Data link performance tests shall be conducted between the T-1 multidrop communications system at the communication hub and each field element cabinet or device (vehicle detection stations, ramp meters and closed circuit televisions). Records of all tests shall be delivered to the Engineer. Bit error rate tests shall be conducted using (1) asynchronous fiber optic modems at 1200 bps and (2) DS1 optical modem at 1.544 Mbps each configured in a loop back path, from the communication hub to the circuit terminus, looped back into the circuit to the communication hub. A BERTS shall be used in a 2 hour test of each circuit. All circuits shall provide an error rate less than  $1 \text{ in } 10^9$ .

All acceptance test results shall be fully documented and such documentation provided as a condition of acceptance.

## **10-7.05 FUNCTIONAL TESTS**

The Contractor shall test all system functions to demonstrate the connectivity of each data channel, that all circuits, and all equipment satisfies the functional requirements of these special provisions.

The Contractor shall document all functional test results. In the event that any aspect of the functional tests are determined by the Engineer to have failed, the Contractor shall cease all acceptance testing and determine the cause of the failure and make repairs to the satisfaction of the Engineer. Acceptance testing shall, at the discretion of the Engineer, be repeated from the start of functional tests.

**Performance Tests.**--The Contractor shall conduct operational performance tests on all data circuits operational from the communication hub to the field equipment.

Data tests shall be performed on all operational and voice/data circuits using appropriate test equipment for the measurement of the following parameters:

End-to-end bit error rate tests shall be run from the communication hub to each remote drop of each data circuit. A data test set shall be used at both the communication hub and the remote modems to insert an asynchronous pseudo-random pattern using 8 data bits, 1 start bit, 1 stop bit and even parity. The data test set at the remote modem must hold RTS high for the duration of the data test. The data rate of the test sets shall be set to rate as employed in the system. A 15 minute test on each drop of each multipoint circuit shall be error free in both directions.

One drop of each circuit, as chosen by the Engineer, shall be tested for 48 hours. The average bit error rate in both directions shall be less than  $10^{-8}$ .

Pulse-width distortion shall be defined as the difference between the data pulse width into a data channel port at the communication hub port and the pulse width out of the EIA-232D port of an interconnected drop modem.

Distortion shall be tested between the communication hub and the selected field modem for each data circuit. The signal shall not have a gross span-stop distortion greater than 20 percent at any data interface measured as per EIA-404-A.

If any circuit or element fails to satisfy the specified performance requirements the Contractor shall determine the cause and remedy the failure to the satisfaction of the Engineer. The full performance tests shall be repeated under operating conditions as determined by the Engineer.

#### **10-07.06 FINAL ACCEPTANCE**

The system will not be accepted until all of the following conditions have been met as follows:

Physical, functional and full performance acceptance tests have been completed and the results are approved by the Engineer.

All documentation has been completed and submitted to the Engineer.

All connections that were changed to perform acceptance tests are restored and tested.

#### **10-07.07 SYSTEM DOCUMENTATION**

The Contractor shall submit a draft copy of all documentation for review and approval prior to production of documentation. The Engineer will review and approve or reject the draft documentation within four weeks of receipt.

The Contractor shall modify the documentation if required and submit provisional documentation. The Engineer will approve or reject the provisional documentation within three weeks of receipt. The Contractor shall arrange for re-submission in a timely manner to meet the schedule in the case that the documents are being rejected.

Draft documentation shall be submitted eight weeks prior to the start of installation. The draft documentation shall show the general approach in preparing the final manuals.

Upon approval of the draft documentation, provisional documentation shall be supplied 3 weeks prior to the start of site testing. The provisional documentation shall be of the same format as the final manuals but with temporary insertion for items which cannot be finalized until the system is completed, tested and accepted. Final documentation shall be submitted no later than 4 weeks after completion of the acceptance tests and shall incorporate all comments made during the approval stages. The Contractor shall be responsible for all delay caused by non-compliance to the specified requirements.

Final documentation shall be approved prior to its production. Five copies of all final documents shall be delivered. The copies shall be 216 mm x 279 mm and bound in three-ring, hard-covered binders, complete with dividers. Documentation shall consist of a operations and maintenance (O & M) manual with drawings and shall include the information necessary to operate, maintain and repair the equipment and cable to the lowest module or component level described. It shall contain as a minimum the following :

**Master Items Index:** This shall be the first section of the O & M manual. The section shall describe the purpose of each manual and brief description to the directory of the manual. It shall also reference equipment manuals as required for additional and support material.

**System Description and Technical Data:** This section shall contain an overall description of the system and associated equipment and cables with illustrative block diagrams. This section shall identify all equipment and cables in the system stating the exact module and option number that are employed in the system. Technical data, specification and settings for every type of equipment or cable shall be provided. Any modification that has been done on the equipment shall be clearly described.

**Theory of Operation:** The manual shall contain a functional description of each element of the system, explaining how each function is being achieved separately and how each element works together to form the complete system.

**Operations:** The manual shall describe how to operate the system and each particular type of equipment and software. Equipment layout, layout of controls, displays, software operating procedures and all other information required to correctly operate the system and each functional unit shall be provided. Procedures shall also be provided for initial tune-up of the system and adjustment and checkout required to ensure that the system is functioning within the performance requirements. Warning of special procedures shall be given. The functions and setting of all parameters shall be explained.

**Corrective Maintenance:** The manual shall include fault diagnostic and repair procedures to permit the location and correction of faults to the level of each replaceable modules. Procedures shall include alignment and testing of the equipment following repair, the test equipment, tools, diagnostic software required and the test set up.

**Preventative Maintenance:** The manual shall include procedures for preventative maintenance in order to maintain the performance parameters of the system, equipment and cables within the requirements of the specifications.

**Parts List:** The manual shall include a list of all replaceable parts with exact parts description and number and a directory of recommended suppliers with correspondence address, telephone and fax numbers.

**Test Results:** This section shall include a copy of the results for all the tests that has been conducted for the contract.

System schematic drawings shall be provided to identify the type of equipment at each location and the function of all equipment. The drawings shall also show how the system is interconnected. A comprehensive list of cabling and wiring shall be provided to clearly identify the interconnection and labeling of all equipment supplied under this contract, State-furnished or existing both in the field and at the communication hub.

#### **10-07.08 PAYMENT**

The contract lump sum price paid for system testing and documentation shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in system testing and documentation, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.